

Research on Contextualized Assessment of Artificial Intelligence Literacy in Primary and Secondary School Students and Implications

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Abstract: Artificial Intelligence (AI) literacy serves as a concrete manifestation of talent development requirements in the era of AI advancement, and the evaluation of AI literacy among primary and secondary school students constitutes a critical mechanism for enhancing their competencies in this field. To clarify the current landscape of AI literacy assessment for these students, this study conducted a systematic literature analysis across three dimensions: the conceptual framework of AI literacy, evaluation components, and assessment tools. Key findings indicate that existing assessment methods predominantly rely on conventional approaches such as self-reported scales, artifact analysis, or hybrid models combining knowledge tests with interviews. These methodologies exhibit limitations in accurately evaluating students' ability to apply AI literacy to solve real-world problems. Context acts as a vital bridge connecting theoretical knowledge with practical realities, fulfilling both connective and supportive roles in problem-solving processes. Guided by the principles of contextualized assessment design, this study proposes a novel situational evaluation framework for AI literacy tailored to primary and secondary school students. This framework aims to advance practical research on AI literacy assessment by addressing the critical need for authentic competency evaluation in educational contexts.

Keywords: Artificial Intelligence Literacy, Intelligence Literacy Assessment, Contextualized Assessment, Primary and Secondary School Students

1. Introduction

With the rapid advancement of generative artificial intelligence, big data, the Internet of Things, and other emerging technologies, human society is transitioning into the intelligence age. Evolving from initial unfamiliarity with and exploration of AI, people are gradually becoming "digital natives" adept at thriving and innovating within AI-driven environments. In this paradigm shift, proficiency in AI-related competencies has emerged as an essential requirement for individuals to navigate and succeed in the intelligence era. The UNESCO report Artificial Intelligence Curriculum in Primary and Secondary Schools: A Study of Government-Approved Artificial Intelligence Curricula explicitly emphasizes that global citizens must cultivate artificial intelligence literacy to effectively adapt to and harness the transformative benefits of intelligent technologies^[1].

The technological revolution driven by artificial intelligence unequivocally demonstrates the need to elevate standards in traditional talent development paradigms. Within this context, primary and secondary education has assumed a renewed mandate: to foster students' AI-driven adaptability and creative problem-solving capabilities, equipping them to navigate complex challenges in intelligent ecosystems. As a core component of modern competency profiles, intelligent literacy has gained critical prominence in holistic education. Nevertheless, existing evaluation systems and assessment instruments for intelligent literacy remain underdeveloped. Establishing rigorous, multidimensional evaluation frameworks represents a strategic imperative for precisely gauging students' intelligent literacy levels. Such systems serve dual purposes: they not only form the foundation for advancing intelligent literacy development but also catalyze the cultivation of innovative talent, ultimately propelling sustainable educational transformation in the intelligence-driven era.

2. Current Research Landscape of Artificial Intelligence Literacy Assessment in Primary and Secondary School Students

Carrying out AI education for primary and secondary school students has become an important way to cultivate future innovative talents, and evaluating the AI literacy of primary and secondary school students is a key link in AI education in primary and secondary schools, which is of great significance in judging the effectiveness of teaching and learning in AI education. According to a series of related research and practice of primary and secondary school students' artificial intelligence literacy by relevant research scholars, this study will discuss the status quo from three dimensions: the connotation of students' artificial intelligence literacy, the elements of students' artificial intelligence literacy evaluation, and the tools of students' artificial intelligence literacy evaluation.

2.1. Connotations of artificial intelligence literacy for primary and secondary school students

From the perspective of the contemporary development of the connotation of AI literacy, AI literacy is the expansion and extension of information literacy, digital literacy and core literacy, as well as its new form and new needs in the era of artificial intelligence. At present, the academic community has not yet reached a unified understanding of the connotation of AI literacy for primary and secondary school students. Some scholars focus on students' individual mastery of certain thinking, knowledge and skills, and explore the connotation of students' AI literacy from the practical perspective of human-computer collaboration. For example, Aida Ponce suggests that in the era of AI, individuals should not only learn AI-related knowledge, but also learn how to communicate and collaborate with AI^[2]; Long et al. define AI literacy as a set of competencies that enable individuals to critically assess AI technologies, communicate and collaborate effectively with AI, and use AI tools in multiple venues^[3]; while some scholars are more inclined to start from the concept of "literacy", compare and analyze each literacy according to the development of the times, and pay attention to the key competencies that students embody when dealing with the challenges of the smart era. For example, Yi argues that AI literacy includes functional literacy (traditional literacy), social literacy (the ability to educate individuals to read and understand society), and technological literacy (the basic technological competencies necessary for the learning era, involving digital literacy, media literacy, ICT literacy, and AI utilization)^[4]. There are also Xu Yafeng et al. who believe that the competencies necessary to carry out a series of behavioral activities such as learning and working in the AI era are AI literacy. They also pointed out that AI literacy intersects with the concepts of mathematical literacy and data literacy, and there is a close connection between the three^[5].

Based on this, it can be seen that students' artificial intelligence literacy is a new concept derived in the context of the intelligent era, and it is a comprehensive ability that students should have in order to adapt to the development of the intelligent era and should be able to meet the needs of social development in the context of intelligence.

2.2. Elements of evaluation of artificial intelligence literacy in primary and secondary school students

From information literacy to today's artificial intelligence literacy, it can be found that each literacy is not static, and its elemental content will dynamically change with the development of technology and the new needs put forward by society for students. In order to better cultivate and evaluate the AI literacy of primary and secondary school students, it is necessary to explore the elemental content of AI literacy for primary and secondary school students. 2022 UNESCO released the report "Artificial Intelligence Curriculum in Primary and Secondary School Stages-A Research on the Government's Recognition of Artificial Intelligence Curricula", which points out that: in the context of the Intelligent age context, everyone is expected to have some degree of AI competence, including knowledge, understanding, skills and values. These can be collectively referred to as AI literacy. AI literacy also includes data literacy (the ability to understand how AI collects, cleanses, manipulates, and analyzes data); and algorithmic literacy (the ability to understand how AI algorithms find patterns and connections in data that can be applied to human-computer interactions)^[1]. Other scholars are also trying to explore the elemental content of AI literacy for elementary and middle school students from a variety of perspectives.

Duri Long and Brian Magerko, two scholars at the Georgia Institute of Technology (USA), proposed a framework structure for AI literacy based on the concept of human-computer interaction with five major themes (what is AI, what AI will do, how AI works, how it is used and how people perceive AI) and 17 specific competencies of AI literacy framework structure^[3]. Hyein et al. from JeJu National University (South Korea) constructed a framework of AI literacy for primary and secondary school

students, which contains five level 1 indicators: experience of AI, understanding of AI, AI and data, AI and learning, and ethics of AI^[6]. Scholars, such as Hou Hezhong, constructed a pyramid model of intelligent literacy based on analyzing the literature, the AI curriculum rollout, and the constituent elements of data literacy, which are the awareness and attitude layer, the knowledge and skills layer, the core thinking layer, and the innovation and creativity layer, respectively, from the bottom up^[7]. Zhang Yinrong et al. constructed an AI literacy index system based on the “Five Concepts of Artificial Intelligence” put forward by the International Working Group on Artificial Intelligence Education Guidance for Primary and Secondary Schools, including three key dimensions: AI knowledge, AI ability, and AI ethics^[8].

From the multidimensionality of the content of the elements of AI literacy for primary and secondary school students proposed by many current scholars, it can be seen that the elements of AI literacy for primary and secondary school students include knowledge of intelligence, awareness of intelligence, attitude towards intelligence and skills to use the acquired knowledge of intelligence to solve practical problems.

2.3. Tools for assessing artificial intelligence literacy in primary and secondary school students

In terms of the assessment of intelligence literacy in primary and secondary schools, most of the current assessment of students' intelligence literacy is carried out by the traditional self-expressive scale test and work analysis, or by a mixture of knowledge test and interview. Among them, questionnaires and knowledge tests are mostly used to evaluate students' mastery of AI knowledge or skills; interviews are mostly used to evaluate non-cognitive factors such as students' awareness of AI and attitudes toward intelligence. For example, scholars Lee et al, designed a 30-hour AI workshop for middle school students who were between the ages of 10 and 14 in order to develop their AI literacy. After the workshop, a self-assessment based questionnaire was designed to assess the students' intelligence literacy^[9]. Scholars Druga et al. measured children's AI literacy by observing 102 children (7-12 years old) from four different countries (the United States, Germany, Denmark, and Sweden) and examining their self-perception and understanding of AI. The assessment tool was designed to be a mixed method combining self-assessment questionnaires and classroom observation^[10]. Some scholars, such as Li Ying, designed an AI literacy evaluation system for primary and secondary school students based on the concept of "evidence-centered" evaluation, using a mixture of scales, topic tests, and work analysis to evaluate the AI literacy of primary and secondary school students^[11].

Most of the existing assessment tools for AI literacy of primary and secondary school students are evaluation tools designed to explore the current status of students' intelligence literacy or point to specific AI education programs, while the lack of integration of different types of assessment tools with the content of the assessment makes it difficult to comprehensively evaluate the overall performance of AI literacy of primary and secondary school students.

3. Research on Contextualized Assessment of Artificial Intelligence Literacy in Primary and Secondary School Students

The core of artificial intelligence literacy lies in students' ability to effectively use their learned intelligence knowledge to analyze and solve problems when facing complex and changing real-world situations. The so-called context, as the key link between knowledge and reality, plays an indispensable role as a bridge in the problem solving process, which not only visualizes the abstract knowledge, but also enables students to deeply understand the application of knowledge in a real context. In view of this, it is particularly important to use context-based assessment to examine students' AI literacy. This way, by skillfully placing the questions in real-life scenarios and allowing students to solve problems by using AI knowledge in simulated or real complex situations, it can comprehensively, realistically and objectively reflect students' ability to cope with problems by using AI literacy in real life, effectively avoiding the problem of disconnecting the traditional assessment methods from reality, and providing educators with a more accurate and more It provides educators with more accurate and valuable assessment results, and helps to promote the relevance and effectiveness of AI education.

3.1. Current landscape of contextualized assessment in artificial intelligence literacy

In terms of contextualized assessment programs, the Program for International Student Assessment (PISA) places more emphasis on students' ability to solve problems in authentic contexts. The program

considers the context to be the background of the problem on which the assessment of these elements is based, whether it is the assessment of mathematical literacy, reading literacy or scientific literacy^[12]. In addition to this, the assessment of ICT literacy in Australia's National Assessment Program (NAP) also uses contextualized assessment, which emphasizes the completion of everyday in-school and out-of-school tasks in a virtual reality context. The assessment program is conducted online at school through a specially designed software application. The software is designed to create a "real-world" virtual environment that is familiar to the students and close to their real lives. All the test questions are presented in the form of contextual tasks, such as creating animated videos to complete the corresponding tasks, slide shows, etc.^[13]. A number of scholars have also studied the development of contextualized test questions for related literacy. For example, Xu Xianlong et al. designed a framework for contextualized assessment of primary and secondary school students' information literacy based on the analysis of literature and contextualized assessment items, which was designed with the idea of clarifying the purpose of assessment, designing the assessment context, preparing specific questions, and finally case application. Among them, a link is established between the purpose of assessment and the real literacy level of students, so that the specific literacy level of students can be understood through their responses in the contextualized questions^[14].

In the field of AI literacy assessment, there has not yet been an authoritative contextualized AI literacy assessment program. It can be seen that there is still much room for research on contextualized assessment of AI literacy in primary and secondary school students. However, contextualized assessment is not just about adding life-like elements to test papers, but also requires comprehensive consideration of various factors. On the one hand, the age, cognitive level and learning ability of primary and secondary school students should be fully taken into account to ensure that the assessment content is not only challenging, but also in line with the actual level of students. On the other hand, it is also necessary to pay attention to the logical coherence between the knowledge points, so that the assessment can comprehensively and systematically examine students' mastery and application of AI knowledge. In addition, the design of contextualized assessment should closely match the real-life scenarios, and select representative and contemporary contextual materials, so that students can better understand and apply their AI knowledge in familiar contexts, thus accurately assessing their ability to solve practical problems in real contexts.

3.2. Design of a contextualized assessment framework for artificial intelligence literacy in primary and secondary school students

Based on the above analysis, there are fewer studies on contextualized assessment of AI literacy of primary and secondary school students, but there are more related studies on contextualized assessment of information literacy. Therefore, this study draws on the ideas of related literacy contextualized assessment studies and designs a framework for contextualized assessment of AI literacy in primary and secondary school students based on the current connotation of AI literacy in primary and secondary school students and its constituent elements, as shown in Figure 1.

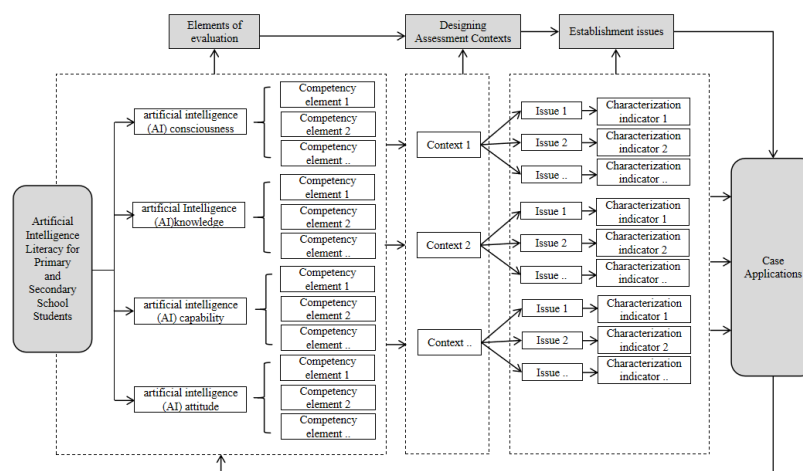


Figure 1: Contextualized assessment framework for AI literacy of primary and secondary school students

The first step in carrying out contextualized assessment of AI literacy for primary and secondary

school students is to clarify the evaluation elements. Evaluation elements are the points of the ability elements that students are going to show in the assessment process, which is an important starting point for the contextualized assessment of literacy. By analyzing the connotation and evaluation elements of the current AI literacy of primary and secondary school students, the first-level components of AI literacy are summarized into four dimensions: AI awareness, AI knowledge, AI ability and AI attitude. After determining these four basic assessment dimensions, it is necessary to further refine the specific performance level of each dimension and clarify the key competency elements contained in each dimension, taking into account factors such as the cognitive characteristics and learning patterns of primary and secondary school students. This helps to accurately correspond to the core competency points when subsequently designing assessment contexts, and to realize the precise matching of evaluation elements and contextual test questions.

In assessing AI literacy among primary and secondary school students, the contexts chosen should not be limited to ordinary life examples, but should be carefully designed to point to situations in which students can develop and practically apply AI literacy. These contexts should reflect the complex problems that students may encounter in real campus learning and daily life, such as how to use AI tools for data analysis in interdisciplinary learning programs. In addition, the design of assessment contexts should be closely centered on the AI literacy competency points that need to be assessed, and the contextual tasks should be deeply explored and skillfully conceptualized to motivate students to invoke relevant AI knowledge, skills, and attitudes to solve problems. For example, if we want to test students' "artificial intelligence ability", we can design a contextual task that allows students to use machine learning algorithms to classify plant species on campus, which not only requires students to master algorithmic knowledge, but also requires them to have the ability to collect and process data, as well as the innovative thinking of applying artificial intelligence technology to practical problems. Thinking. Through the design of such assessment contexts, we are able to assess students' comprehensive AI literacy more comprehensively and accurately, provide educators with valuable feedback, and thus promote the continuous improvement and development of AI education.

In the contextual assessment of AI literacy, the context is an important means of introducing students to a specific environment, while the questions to be solved are the key to promoting the development of the contextual tasks and the students' completion of the tasks. Therefore, the preparation of questions must be based on the context and the elements of competence, and the questioning method must be designed closely around the process of advancing the task in the context. In the process of students' problem solving, they show a variety of behaviors that can reflect their actual performance in different elements of competence. Specifically, the preparation of questions should focus on the following points: first, the questions should be closely related to the context, can be naturally integrated into the context of the background, so that the students can quickly associate with the corresponding situation when facing the problem, and use the artificial intelligence knowledge and skills required in the situation. Second, the questions should be designed to address specific competency elements and explicitly test students' mastery of a particular competency. Finally, the difficulty of the problem should be moderate, which can stimulate students' thinking and desire to explore, but not so much that students feel helpless, to ensure that students can fully demonstrate their abilities in the process of problem solving.

4. Conclusion

At a time when the intelligent era is booming, the education system for primary and secondary school students is facing brand new challenges and opportunities, and artificial intelligence literacy is gradually becoming a key part of students' comprehensive ability training. Artificial intelligence literacy, far from being just a pile of theoretical knowledge or mechanical memorization of operational skills, emphasizes the ability of students to closely link what they have learned with real life, and to flexibly use intelligent technological tools to discover, analyze and solve practical problems. The cultivation of such literacy aims to equip students with innovative thinking and practical ability when facing complex and changing social situations, and enable them to utilize the power of artificial intelligence to promote efficient problem solving and sustainable personal growth.

Based on an in-depth analysis of the connotation of AI literacy of primary and secondary school students, evaluation elements, and existing evaluation tools, the study designed a set of contextualized assessment framework for AI literacy of primary and secondary school students in response to the problem of detachment from the actual context that exists in the current assessment methods. This provides a more scientific and comprehensive perspective for the assessment of AI literacy of primary and secondary school students. It puts students in real social situations and learning tasks by carefully

designing various learning and life scenarios that are close to reality. In these specific and vivid situations, students need to apply their acquired AI knowledge and skills to cope with and solve a series of complex problems. By carefully observing and analyzing students' actual performance in the contextual tasks, we can truly reflect their ability to apply AI literacy in the problem solving process, and then realize the comprehensive evaluation of their intrinsic literacy. This kind of evaluation not only pays attention to students' mastery of knowledge, but also pays more attention to their innovative thinking, practical ability and problem solving strategies in actual operation, which provides educators with richer and more accurate feedback information and helps to promote the continuous optimization and improvement of AI education.

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