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CAN AI BE USED AS A WAY OF THINKING TO FOSTER STUDENTS' CREATIVITY? AN EMPIRICAL STUDY BASED ON CHINA

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ABSTRACT
In the rapidly changing field of Artificial Intelligence (AI), educators are seeking ways to empower youth to shape the future. However, there is a lack of research on AI curricula for K12 students, particularly in Asia. AI can serve as a new avenue for enhancing creative thinking among young people. An experiment was implemented in a public secondary school in mainland China to design a kids' artificial intelligence design program, called Kids AID. A total of 42 secondary school students (average age 15) participated in the program. The study employed both qualitative and quantitative methods. Findings indicated that (1) students need to train in AI thinking to augment their basic AI knowledge and skills; (2) students believe that their creativity, especially its value, diversity, and originality, can be fostered through the design education program; (3) in regard to the student's perceptions of the Kids AID program, 72% of the students liked the teaching methodology and course content, and they believed that the combination of traditional Chinese culture and coding helped them to immerse themselves in learning. This research highlights the benefits of teaching AI thinking and using design as a means to prepare students for a future influenced by AI. The outcomes aim to guide educational researchers in developing AI curriculum and nurturing the next generation of creative talent.

Keywords: AI Literacy, Design, Creativity, Design Education, 21st Century Abilities

1 INTRODUCTION

Artificial Intelligence (AI) growth leads to AI education being seen as a strong driving factor for global competitiveness and the development of the future workforce [1]. Currently, understanding of AI education can be broadly classified into "cultivating AI literacy" [2] and "AI empowers education" . The former refers to at the AI age, a set of knowledge skills for individuals to use AI technology to proceed with critical thinking, effective communication, and collaboration, and to make AI a beneficial tool [4]. The latter involves applying AI and related technology to the educational environment [5].

In secondary education, AI literacy aims to equip students with essential skills for future innovation. Long and Magerko[2] identified seventeen competencies and design factors crucial for this development. By enhancing these skills, non-technical students can effectively leverage AI's advantages and decide when to utilize AI or human abilities for problem-solving. It's vital for these learners to understand not only the basic concepts and applications of AI but also the associated risks, such as algorithmic bias and ethical dilemmas, to ensure responsible use in their careers [6]. Research on AI literacy predominantly centers on Europe and the U.S., with limited focus on Asia [7] and much of the existing literature emphasizes early childhood and primary education[8]. Research in secondary education primarily examines teaching fundamental AI development techniques[9],enhancing digital literacy through technical skills [10], and fostering interdisciplinary abilities[11]. Studies on AI literacy development have largely concentrated on basic concepts and definitions[2,7], with a notable lack of research in curriculum design and educational tools[12,13]. Additionally, students often encounter difficulties in grasping AI concepts due to a lack of clear examples and relatable terms[14]. Encouraging AI thinking in students may help address these challenge[11]. The study's importance stems from the growing integration of AI technologies into people's daily routines and the imperative to comprehend theses technologies among secondary school students. It is essential that the introduction of AI-related content into the secondary school curriculum be designed with meaningful activities to help develop basic AI

thinking in secondary school students. Earlier research has shown that AI thinking development projects for secondary school students in the classroom can have a positive impact on students' basic AI knowledge and inquiry skills[15]. This study aims to (1) explore effective methods for teaching AI to secondary school students; (2) examine the learning process of AI among school students and its potential to enhance their AI thinking and creativity, particularly in understanding fundamental AI concepts and AIGC. These objectives are set to understand the overall effectiveness of AI education and its impact on students' creativity and perceptions.

2 LITERATURE REVIEW

In 2013, researchers introduced AI thinking, which includes practical frameworks, skills, and tools derived from AI research. This concept significantly influences formal education[16]. Rosenberg[17] characterizes it as machine-based intelligence, while Gadanidis[18]proposes that integrating AI with math education can promote its advancement. Additionally, AI thinking functions as an analytical tool, assists in representing complex knowledge, and contributes to the development of AI. The probabilistic reasoning utilized in AI closely parallels human cognitive processes, allowing for intuitive solutions to uncertainties in the real world. This reasoning, along with logical reasoning and deep data-driven learning, forms the essential theoretical framework of AI thinking[19,20].

Research emphasizes the benefits of integrating artificial intelligence (AI) education into secondary schools. David[21]points out that AI reasoning is complex, blending scientific and humanistic thought, similar to human cognition. This makes AI reasoning a valuable educational method that connects science and the humanities. Seoane-Pardo[22] views AI reasoning as an effective teaching tool that enriches learning experiences, particularly in moral reasoning and philosophical inquiry, helping students grasp ethical concepts. The ethical implications of AI are as important as its technical aspects, making AI reasoning essential for philosophical discussions. How and Meng-Leong et al.[23] highlight the significance of the "A(art)" in STEAM education, which includes both fine arts and social sciences, creating opportunities for interdisciplinary teaching that combines scientific logic with humanistic reasoning. This approach enhances students' AI reasoning and overall learning. It is crucial to equip students with problem-solving skills that integrate STEAM fundamentals and AI principles [24,25]. STEAM education has been successfully integrated into K-12 curricula, benefiting students from kindergarten to secondary levels. Examining AI reasoning's role in educational support can improve learning processes[26]. However, there is a gap in systematic training programs for secondary students, especially those using empirical methods with software or programmable robots to teach STEM concepts[5].

There are notable differences in expectations for teaching AI literacy to children of different ages. Younger children need a basic grasp of AI concepts, while older students require a deeper understanding. To enhance AI literacy in secondary education, researchers have created targeted curricula. For example, Han et al.[9] used a project-based learning model to provide secondary students with hands-on AI experiences through various activities. Similarly, Julie et al.[10] utilized role-playing to allow students to develop and test AI programs, fostering critical reflection on their AI knowledge. These studies highlight the benefits of teaching AI skills to secondary students and the significance of AI thinking initiatives in education. Terzidis presents a framework that integrates AI knowledge, ethics, and skills to nurture AI thinking in children, which evolved into the kids AI thinking framework, aimed at helping students understand and creatively apply AI in their daily lives.

3 METHODS

The research aims to assess how a six-week program focused on artificial intelligence design for kids, named Kids AID, influences secondary school students' AI thinking, and their attitudes towards the program. The data were collected from 15–16-year-old students at a Shanghai secondary school, in China. The choice of Shanghai, China as the research site stems from its dual role as an economic center and a leader in education reform, making it ideal for examining AI thinking. With the rise of Artificial Intelligence Generated Content(AIGC), researchers in China are focusing on its effects on students and advocating for its application in education. This context is relevant for the study. The two primary research objectives are as follows (1) to explore effective methods for teaching AI to secondary school students; (2) to examine the learning process of AI among school students and its potential to enhance

their AI thinking and creativity, particularly in understanding fundamental AI concepts and AIGC. This research will endeavor to investigate the following research hypotheses:

- RQ1: To what degree does the program enhance the participating secondary school student's comprehension of AI thinking?
- RQ2: How do secondary school students perceive their creativity ability after carrying on some AIGC Art activities?
- RQ3: What are the secondary school student's perceptions towards the Kids AID intervention?

The researcher employed a mixed-methods strategy, integrating both quantitative and qualitative analyses to enhance the clarity of the research question. Knowledge assessments and interviews served as the primary tools for data collection. The interviews aimed to uncover students' views on the Kids AID program. The collected data was organized and classified to support the qualitative analysis.

3.1 Participants

Forty-two secondary school students from Shanghai, averaging 15 years old, participated in a study within one classroom. They were split into six groups of seven, with three groups as experimental and three as control. Both groups worked on the same project topics, but the control group of 21 students used traditional thinking skills, while the experimental group applied AI-based skills. After the project, interviews were held with the experimental group. The chosen school is a public school in Shanghai, China, which has an innovative teaching philosophy that combines a basic curriculum that emphasizes knowledge output with an innovative curriculum that emphasizes experiential learning. It has a high match for the selected topic of this study, and the school principals, teachers, and students' willingness to take part in the research. All students in the sample had no previous AI education. All processes for this study have been approved by the university. Prior to participation, schoolteachers, parents/guardians, and students provided informed consent by signing a consent form. Parental consent was obtained for students' participation. Authorization was granted for the use of photographs and videos in this study, with participant names obscured in the presentation.

3.2 Implementation Procedures

During a six-week period, two groups collectively completed the Kids AID curriculum. Instruction for this program was provided by one professor, two researchers and one teaching assistants. The Kids AID program sessions occurred weekly, each lasting approximately two hours. Before implementing the Kids AID curriculum, two teachers from the secondary school attended a face-to-face teacher training. They were introduced to the Kids AID curriculum, including learning objectives, instructional content, and pedagogical methods. The study was conducted between May and July of 2024.

3.3 The Kids AID Curriculum

The Kids AID curriculum comprised six two-hour sessions conducted at one Shanghai public secondary school. It was implemented as an after-school projected-based learning initiative. The Kids AID program for AI classes is a curriculum structured around four AI learning tools (i.e. AI Technical, Animated Drawings, AIGC Art, Self-portrait), as seen in Figure 1.Terzidis and Rong[27]developed an AI curriculum designed for K-12 students, including four aspects, namely AI Knowledge, AI ability, AI Philosophy and AI Ethics. In this study, this AI curriculum was used in the secondary school students' setting (Table 1).

Table 1. The outline of Kids AID curriculum design for secondary school students

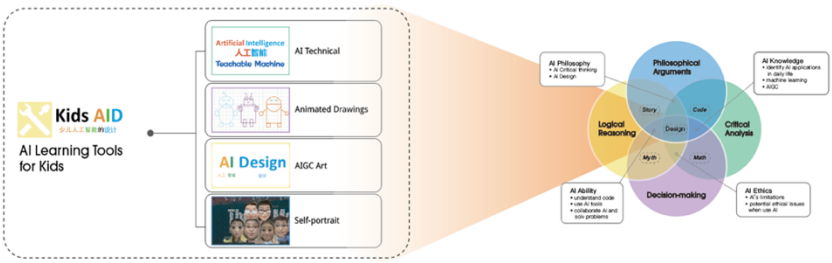

Figure 1. The model of using AI Learning Tools

AI Philosophy	AI Knowledge	AI Ability	AI Ethics
Ph1: AI critical thinking	Kn1: identify AI applications in daily life.	Ab1: understand code	Et1: AI's limitations
Ph2: AI Design	Kn2: machine learning	Ab2: Use AI tools	Et2: Potential ethical issues when use AI
	Kn3: AIGC	Ab3: collaborate AI and solve problems	

The Kids AID curriculum was crafted in accordance with Scott's [28]curriculum design model, which prioritizes four essential components: learning objectives, content, instructional methods, and assessment. The curriculum includes three phases: basic knowledge phase, story phase and practical phase. The initial phase constitutes a foundational stage primarily centered on the concept of AI, as well as the exploration of potential ethical consideration associated with its utilization. The second phase is philosophical arguments, through story, myth, and jokes to deliver the hidden massive power of AI. The third phase is the practice and applied phase which mainly focuses on machine learning and AIGC. While each unit addresses a unique subject, the lessons maintain a coherent progression. In addition to enhancing their understanding of AI, secondary school students also cultivate their creativity in AI design as a result of engaging with the Kids AID curriculum.

The two methods of teaching used in the Kids AID program are project-based learning and play-based learning. Project-based learning is a great approach that exercise students to learn through independent enquiry, with the teacher acting as a facilitator[29]. Play-based learning takes the form of guiding students through game-playing activities as a method of instruction[30]. It is worth mentioning that although play-based learning is mostly used in the kindergarten level. That doesn't mean it can't be used with other age groups. Play is a powerful tool for identifying the neural and psychological mechanisms behind interpersonal and group cooperation and coordination[31]. Kafai argued that learning is undoubtedly a difficult task for students and that need games to "sweeten" the concept of learning difficulties[32]. Two learning activities based on game-based learning were designed for this study.

3.3.1 Basic Knowledge Phase

The purpose of Unit 1 is to provide secondary school students with an understanding of the principles of various AI techniques, including their concept and apply. The aim of Unit 2 content is to expose students to situations that AI might not have encountered through the creation of stories to illustrate the need for continuous improvement in AI technology and AI applications. Ideally for students to understand these concepts related to AI, students would need to first master computer programming languages. In the Unit 3, students can use p5.js, a very inclusive and accessible platform to learn, exercise how to communicate with computer. This creative programming library is obviously very friend and appropriate choice for secondary school students at the basic education level in China.

3.3.2 Story Phase

The use of culturally embedded mythology to practice students' philosophical mindset and lead them to the door of AI is the aim of Unit 4. AI intelligence and philosophical epistemology share a commonality, i.e., the study of how the mind works. And as a product of thought and consciousness, the study of myths allows for speculation about human ideas and ways of thinking. One of the key skills required for AI thinking is the ability to think creatively and make connections between different ideas. Studying myths can help develop this skill by exposing students to a variety of stories and symbols that need to be interpreted and analyzed. By learning how to interpret these symbols and understand their meaning in the context of a story, students can develop their analytical skills and learn how to make connections between different ideas. In addition, many myths involve characters who face complex problems or moral dilemmas. By analyzing these stories and discussing the choices made by the characters, students can develop their ability to evaluate arguments and consider different viewpoints based on ethical considerations. This is an important skill for engaging in AI thinking.

3.3.3 Practical Phase

In Unit 5, students learn the concepts and principles of machine learning, learn to utilize the AI tools

Animated Drawing, and explore methods to enhance the accuracy of AI drawing recognition. Students can enhance their communication skill and problem-solving skill after the Unit 5 project. They used Animated Drawing and Teachable Machine to carry out these activities. Through the Unit 6 and 7, students can learn the use skills of AIGC and acquire the ability of think out of the box. For example, students will be asked to use AIGC tools (i.e. Midjourney, Ernie Bot) to create Self-portrait activity. Following the study of different artworks generated by AIGC tool, we engage in a discussion regarding the ethical implications of AI (i.e. "Will AIGC's creativity surpass humans?"). It is to experience and experiment with different expressions of AI art using AI image processing technology. Students complete their analysis and reflection of the self by examining and interpreting the self and then combining AI technology to collect, decompose, compare, and integrate their characteristics. Unit 8 summarized all learning modules.

3.4 Collection of Data

Assessment, observation, and project implementations were utilized to evaluate secondary school students' proficiency in AI knowledge and skills, encompassing assessments in AI and machine learning, as well as evaluations of AI thinking in secondary school were assessed. Each evaluation was conducted independently, with participants spent 10 minutes for each test.

3.4.1 AI thinking skill assessment

AI thinking skill questionnaire was used to assess student's AI and machine learning knowledge at the end of Kids AID curriculum. It's developed through several iterations by the Research group on teaching Artificial Intelligence thinking. The group comprised of two AI professors and three experts specializing in STEM education, collaborated with four teachers holding primary positions to ensure the validity of our research instruments. The questions comprised 16 multiple-choice questions, with correct answers awarded 1 point and incorrect answers receiving 0 points. High inter-scorer reliability was confirmed through reliability tests. A pre-test was not conducted as none of the students had been exposed to AI before.

3.4.2 Creative Abilities

In the current study, two tasks assessing creative abilities were utilized. Two researchers served as raters for the assessment. The research tools utilized in the experiment included: (1) A metric for assessing the creativity of self-portrait works. Based on the characteristics of the curriculum, the chosen metrics in this study encompass the dimensions of value, diversity and originally [33]. A Richter scale of five is used with an α coefficient of 0.807. Value is the practical ability of the work to satisfy the student. Diversity means the variety of design solutions highlighted in the selected work. Originality refers to the work that is interesting, unique, and novel. (2) An interview outline. The interview questions were as follows: What dimensions of AI thinking learning from the curriculum were useful to you as you worked on your self-portrait? Can AI thinking be used to solve problems in your life? Before the Kids AID projects, had you thought about applying AI thinking in your life? What do you think about AI thinking? Is there a difference for you between this AI thinking skills and the traditional thinking skills handed to you in school?

3.5 Data analysis

We collected different types of data, as shown in Table 2. At the end of the project, 6 boys and 5 girls who participated in the Kids AID curriculum participated in interviews. Data1,3,5 was respectively used to address the RQ1. Data 2,3,4 were employed to tackle the RQ2. And the RQ3 involved the use of data 3.

Table 2. Outlines data collection methods for a variety of research questions

No.	Instrument	Data Type	Data Source	RQ
1	Questionnaire	Questionnaire date	Individuals	Q1
2	Metric	Evaluation of the creativity of Self-Portrait	Individuals	Q2
3	Interview Outline	Interview date	Individuals	Q1, Q2, Q3
4	-	AIGC Art works	Groups	Q2

5	-	Individual and group project proposal	Individuals and groups	Q1

To answer Q1, we used statistical techniques like independent sample t-tests and paired sample tests to evaluate data from post-test surveys. For Q2, we applied an independent sample t-test to assess the creativity of AIGC works. In addressing Q3, we examined student interview data to investigate how AI thinking could enhance awareness in solving real-world issues. We also analyzed both in-process and final AIGC works to determine AI thinking's effect on students' creativity in their art. Lastly, we coded interviews to clarify how AI thinking influences creativity and to gain insights into students' views on the Kids AID program.

To ensure reliability, we took several steps, which are outlined below. The tests were conducted on a computer platform, with automatic scoring by the system. This computerized scoring minimizes bias, especially in objective questions, which have clear correctness criteria like multiple-choice or true/false formats. After training in assessing the creativity of AIGC works, the two researchers used shared metrics for evaluation, leading to a common understanding of the criteria. They then independently applied these metrics to the remaining works. The reliability coefficient of the scores was notably high at 0.807, with values for value, diversity, and originality at 0.550, 0.878, and 0.816 respectively (see Table 3). For analysis, the average scores from both researchers were used, reducing potential bias from individual assessments.

Table 3. Scores on the creativity of Self-Portrait AIGC works of students across two groups

Dimension	Group	n	M	SD	*t*	*p*	Reliability*
Value	Control	21	3.524	0.602	-3.576	0.001**	0.550
	Experimental	21	4.357	0.882			
Diversity	Control	21	2.095	0.605	-14.976	0.000**	0.878
	Experimental	21	4.548	0.445			
Originality	Control	21	3.138	0.759	-7.48	0.000**	0.816
	Experimental	21	4.619	0.498			

* The Spearman's Rank Correlation Coefficient was used to check the reliability of scores on the creativity.

We established a coding framework to analyze interview data on students' views of the Kids AID curriculum. We utilized a general inductive method to analyze the data, which involved summarizing the information, linking it to our research goals, and forming a framework to clarify the perspectives found in the data. To maintain coding consistency, we applied the independent parallel coding technique, where two researchers coded the data separately and then discussed their findings with a third researcher, resulting in 20 categories of perspectives. Following this, two researchers analyzed the interview data (n=11) using the established framework.

4. RESULTS

The test outcome revealed that the control group scored a 5.095-point lower compared to the experimental group. This shows that the Kids AID program had a beneficial impact on students' acquisition and comprehension of basic AI concepts and machine learning skills.During the interviews, 81% of the students indicated that they were able to master the concepts and knowledge of AI through the Phase 1 Basics section. On this basis, 36% of the students said that the form of combining the knowledge of traditional Chinese culture and programming enhanced the fun of learning and practiced math skills, which was very immersive. In comparison to the control group, the experimental group exhibited a 1.01-point increase in the value dimension ($p<0.001$), a 2.45-point increase in the diversity dimension ($p<0.001$), and a 1.48-point increase in the originality dimension ($p<0.001$). Additionally, the creativity score of AIGC artworks in the experimental group exceeded that of the control group by 4.76 points ($P<0.001$).

4.1 Develop creativity ability through the AIGC art activities

The significance of the work lies in how it enables students to effectively utilize AIGC technology. The control group produced artwork through a spontaneous approach to the project theme, lacking formal

training in directing the AI painting chatbot with specific prompts. Instead, they relied on instinct, resulting in visually appealing but random outputs. Conversely, the experimental group created their artwork after learning to communicate with the AI chatbot and understanding its underlying principles. They grasped how the AI generates images based on keywords derived from existing works and learned to refine their creations through targeted adjustments. In contrast, the work of the students in the experimental group was done after they had learned how to talk to the AI painting chatbot. They also learned about the principles behind it, understanding that this AI program generates various types of images by keywording them after collecting data from many existing works and then algorithmically parsing that data. By gaining a deeper understanding of the theme, they also learned to make targeted adjustments and optimizations to the generated artwork through image commands.

The statistics on the themes of the students' work show that AIGC artwork can reflect diversity. There were only three different themes in the control group. 10 of the students' art works were urban impressions and chose the same urban architecture as the element of creation. Another 6 students chose the theme of heroes for their creations and the remaining 5 students had the same popular singer as their theme. Conversely, the artworks of the 21 students in the experimental group could be categorized into 5 categories, which were Childhood (3 students), Ecological Protection (4 students), Defense of the Universe (5 students), Cooperation in Solidarity (5 students) and Future Imagination (4 students). At the same time, they also passed the prompts several times to optimize the generated works.

The originality can be demonstrated through the unique perspective from which the students think about the artwork and the presentation of the work. The control group students' artwork was not seen as original by the teachers because "the originality of their artwork was highly randomized, not the originality of the students' own ideas, but the originality of the algorithms used randomly." In contrast, the teachers believed that the experimental class's work was more original because "the students understood how the AI drawing chatbot worked, and they knew how to guide the AI through the conversation to adapt their work step-by-step until they presented the ideas in their minds," where Student A in the experimental group tested and modified her work until she designed her own work, "Childhood". "She said that this is what her childhood looks like in her dream, the atmosphere, colors, texture and elements that are hard to describe in words can't be depicted no matter how much she paints with a brush. But AIGC helped her to do it", said the teacher, "This is a very precious originality in our opinion, something that can't be duplicated no matter what. These things exist in the student's own mind, in their imagination."

4.2 Enhance the awareness of using AI thinking in daily life

Utilizing AI thinking as a way of thinking about everyday life can help students solve problems better. In the student interviews, 36% of the students had never considered using AI technology and AI thinking to address their experience of the problems in their daily lives before the project started. There were 54% of students who had thought about it, but since they did not know how to use AI, the idea was just a display of positive attitude. In contrast, when finishing the program, 90% of the students expressed their willingness to use AI thinking, which is a significant increase from before. Among them, 72% of the students believed that AI thinking helps to help them think multidimensionally. Meanwhile they indicated that they enjoyed this teaching methods and curriculum content. 54% of students believed AI thinking helps them to think outside the box, and 27% of the students believed that adopting this way of thinking helps them to improve the efficiency of their learning.

5. DISCUSSION

The purpose of this study is to identify how a six-week intervention in the Kids AID program influenced secondary school students' AI thinking. The curriculum includes three phases: basic Knowledge phase, which introduces AI concepts and ethical considerations; the story phase,which uses narratives to highlight AI's potential, and the practical phase, where students engage in hands-on machine learning and AIGC activities.The results show that the program successfully achieved its goals, significantly improving students' AI knowledge and skills, as reflected in higher test scores and positive interview feedback. The blend of traditional Chinese culture with programming proved to be an effective method for teaching AI concepts.

Integrating design thinking with artificial intelligence presents a valuable strategy for addressing organizational challenges[34]. How and Hung[23] proposed that AI thinking can empower students to apply their knowledge effectively to real-world issues in their academic and professional lives. This research reinforces previous findings and emphasizes the beneficial role of AI thinking in problem-solving. It highlights the importance of students utilizing AI tools when confronted with practical challenges. The program notably enhanced students' understanding and application of AI thinking, leading to a marked increase in their willingness to incorporate AI into everyday situations, thereby deepening their comprehension of AI and its uses. Gadanidis [18]noted that AI in education can promote AI thinking, encouraging students to engage more critically with problems and ask insightful questions. This study indicates that as students learn about AI thinking, they not only gain knowledge but also cultivate active thinking skills applicable to their studies, work, and life, enabling them to approach problems creatively. Students reported improved problem-solving efficiency and broader thinking, indicating a positive shift in their cognitive strategies. These results have important implications for AI education in secondary schools, suggesting that programs like Kids AID can enhance students' AI knowledge, creativity, and awareness, and that incorporating cultural and creative aspects into AI education can boost engagement and learning outcomes.

Previous research has shown that AIGC technology can inspire creativity and imagination in creators [35], aligning with the assessment criteria of value, diversity, and originality[33]. In earlier studies, students followed their teacher's design steps, while this study's control group utilized a project-based learning method focused on their interests. Conversely, the experimental groups learned specific methodologies. Results revealed that the Kids AID program effectively enhanced students' creativity, reflected in improved scores across the creativity dimensions. Engaging in AIGC art activities enabled students to creatively interact with AI tools, deepening their understanding of AI and fostering innovative thinking. Qualitative data from student interviews corroborated these findings, showing that AI thinking encouraged multidimensional and unconventional thought. Students showcased their creative application of AI by producing original artworks with AI assistance. This underscores the potential of integrating AI thinking and AIGC technology into education to enrich learning experiences, emphasizing the significance of creative activities in student engagement.

6. CONCLUSION AND LIMITATIONS

Three conclusions emerge from our findings. First, using the Kids AID curriculum as a method of cultivating students' AI thinking can effectively solve the problem of mastering basic AI knowledge and concepts in the process of improving AI literacy among secondary school students. Second, the AI thinking method exercises students' logical thinking. In the process of cultivating AI thinking for secondary school students, by introducing curriculum content containing mythological stories and cultural meme jokes of traditional culture, students can enhance their analytical abilities and engage in problem exploration and discovery, thereby effectively bridging the disparity between AI learning and real-world applications. Finally, the learning and use of AIGC technology helps students to stimulate their imagination and promotes their initiative in exploring and solving problems. This enables students to actively construct knowledge and skills and improves the passive learning of students in the Chinese education model.

We provide a new way of thinking about problems in our research, the AI thinking framework. And based on this, we provide some experimental courses and assessment methods for researchers' reference. Although most students in China can acquire knowledge of AI by consulting materials or taking courses, they are still very poorly equipped with the philosophical thinking, critical thinking, programming, and logic skills needed to master AI. This study first proposes a framework for effective learning that includes both overall process and specific content. Second, students were encouraged to actively utilize advanced AI technologies such as AIGC for learning, self-exploration, and application in real-world contexts. This fosters skill acquisition and enables students to effectively navigate the AI era.

Finally, we recognize several limitations within our study that require further research and refinement. First, the examination of the course was based on interview data obtained solely from 11 students in the experimental group, which is a relatively small sample size and may offer a constrained viewpoint. Subsequent investigations could explore whether similar results would be obtained with a large sample

size, which would be of value. Second, this study did not include faculty interviews to gather their perspectives on the curriculum and AI thinking. Future research could build on this and add to the teacher perspectives to explore how to better support students' AI literacy development in the current educational environment. Finally, the content of this study only explored the outcomes of students' practice in the AIGC and machine learning environment. Therefore, future research may add new programs such as neural network practice experiments to more refine the content of the AI mindset model and draw more specific and comprehensive conclusions.

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