ĀTPM Vol. 32, No. 4, 2025
ISSN: 1972-6325
https://www.tpmap.org/

DESIGNING K–12 ARTIFICIAL INTELLIGENCE CURRICULUM FROM AN EDUCATIONAL PSYCHOLOGY PERSPECTIVE

JIN WANG[1], LEI PENG[1], CHENJIA LIU[2], TING LIU[2], XI LAN[3], YING SUN[4], WENDAI YANG[5*]

[1]XINZHOU NORMAL UNIVERSITY
[1]XINZHOU NORMAL UNIVERSITY
[2]XINZHOU NORMAL UNIVERSITY
[2]INSTITUTE OF EDUCATIONAL RESEARCH, DEPARTMENT OF EDUCATION, SUNGKYUNKWAN UNIVERSITY
[3]THE CHINESE UNIVERSITY OF HONG KONG
[4]DALIAN MARITIME UNIVERSITY
[5]CENTRAL CHINA NORMAL UNIVERSITY, EMAIL: sharemali@outlook.com

Abstract: The rapid expansion of artificial intelligence (AI) has accelerated the global movement to embed AI learning in K–12 education. Yet, designing age-appropriate, coherent, and pedagogically grounded AI curricula remains a significant challenge for schools and teachers. Drawing on four established curriculum approaches—content, product, process, and praxis—this study develops a holistic framework for guiding K–12 AI curriculum design. Thirty teachers from ten secondary schools in China participated in this qualitative study. Data included semi-structured interviews, 12 sets of teaching materials, and course meeting minutes. Using thematic analysis, the study identifies two overarching themes and six core design components that teachers consider essential for AI education. Findings reveal that teachers must balance mandated curriculum goals with student needs, school resources, and local policy contexts. Unlike approaches that emphasise only content knowledge or technical skills, the proposed framework underscores the importance of student-centred learning, ethical reasoning, and real-world problem-solving.

Keywords: Artificial Intelligence Education; K–12 Curriculum Design; Curriculum Theory; Content–Product–Process–Praxis Framework; Teacher Perspectives; Thematic Analysis; Educational Technology

1. INTRODUCTION

The rapid advancement of Artificial Intelligence (AI) is revolutionising our lives, learning, and employment. The widespread use of AI applications has enormous ramifications for society and future generations. AI education must transition from experts to the mainstream as it has expanded beyond professional and academic research (Xia et al., 2022; Chiu & Chai, 2020). K-12 classrooms are including AI issues, formerly only covered in higher education, as a global strategic push (Kooli, 2023). The goal of this effort is to educate future generations. K-12 AI education can inspire future users, ethical designers, software engineers, and researchers by educating students about developing technologies and their operation (Tapalova & Zhiyenbayeva, 2022). However, K-12 curriculum design is more complicated than higher education. K-12 education is diverse in terms of student ability, interest, and needs, as well as resources, visions, and teacher qualifications. Different schools may teach different subjects, such as ethics, cloud computing, and AI application creation. Teachers may build activities for local and global AI learning. The implementation of this new project is a concern, as its implementation can vary greatly amongst schools. Hence, building AI-related curricula is challenging.

Few studies have explored how to build a quality K-12 AI curriculum in line with worldwide initiatives. Curriculum design theory informs practitioners and researchers (Ng et al., 2024; Chiu et al., 2024). This study used the four aspects of curriculum (content, product, process, and praxis) as a framework for designing holistic AI education for K-12 schools.

2. LITERATURE REVIEW

Curriculum encompasses all student experiences in education, designed and supervised by teachers and learnt in diverse settings (Anderson & Krathwohl, 2001; Simunovic et al., 2010). The research identifies four approaches to curricula: content, product, process, and praxis (Kelly, 2009; Grundy, 1987; Glatthorn et al., 2018). This is useful for curriculum innovation research and practitioners building or changing curricula.

Education is seen as the transmission of knowledge when curriculum is viewed as content. The emphasis is on subject content, syllabus, and successful teaching methods (Chalmers, 2003; Glatthorn et al., 2018; Kelly, 2009). Teachers will adhere to curriculum recommendations, including subject order, knowledge organisation, and

instructional methods. Teachers can focus lesson planning on the knowledge they want to impart. The curriculum is justified by its content, not its outcomes. This viewpoint is prevalent in primary school instruction. Seeing the curriculum as a product emphasises the importance of instruction in improving student competencies.

Student performance and competency are key components (Bonnett, 2002; Swanson & Gamal, 2021), with assessment of learning outcomes as the major objective (Glatthorn et al., 2018; Guion & Swanson, 2018). Curriculum creation is considered a technological task. This approach prepares students for specific activities, requiring careful curriculum development to address their learning needs. This technique is used in technical, skill-based training programs that focus on specific tasks or jobs. Competency lists often dictate what and how students should learn, limiting their input. This strategy emphasises education by focussing on pre-defined outcomes. Both approaches generate implementation-focused documents. Recent student-centered models emphasise process and praxis, shifting the focus from teaching to learning (Kelly, 2009). The curriculum-as-process approach emphasises teacher-student interaction and content creation to match student needs, rather than pre-defined content and outputs.

As triadic connections evolve, learning goals will shift (Kelly, 2009). Glatthorn et al. (2018) define the curriculum as a guideline for teaching practice, rather than a uniform set of topics for all teachers to cover in their courses. Chiu & Chai (2020) and Chiu et al. (2021) provide insight into how teachers and students plan and assess lessons in the classroom. Content selection is based on student needs and interests, and learning outcomes are customised through teacher-student interactions. This method views students as subjects with a voice, rather than objects of instruction (Chiu & Hew, 2018). Viewing the curriculum as praxis emphasises teaching as committed activity, connecting knowledge to real-world applications (Glatthorn et al., 2018; Grundy, 1987). Teachers guide students in collaboration to solve real-world problems by developing action plans to acquire topic knowledge and achieve outcomes (Chiu, 2021). The learning process and outcomes are constantly assessed.

The curriculum approach significantly impacts teaching and learning practices (Dai et al., 2023). Content method emphasises teacher-centered instruction, product approach emphasises drilling and practice, process approach involves student-centered activities, and praxis approach emphasises problem-based learning. The methods to curriculum design are not mutually exclusive (Glatthorn et al., 2018; Kelly, 2009). Proponents of the process approach view content selection as secondary, rather than dismissing its importance. Both content and product approaches emphasise behavioural characteristics and structured curricula with objectives and attainment targets as teaching goals. The process and practice approaches view the curriculum as an active process that integrates planning, acting, and assessing (Lebow, 1993). The authors use student-centered learning theory and educational and developmental psychology. Teachers recognise and develop student strengths, encourage active learning, and collaborate with students to create the curriculum.

3. METHOD

3.1 Research Design

This study employs a comprehensive perspective and four curriculum approaches to explore the design of artificial intelligence (AI) education in K-12 schools. Teachers' perspectives are crucial for understanding the integration of AI technology into curriculum design (Chiu & Churchill, 2016). This study integrates content, product, process, and practice approaches into a single framework to examine teachers' perspectives and teaching methods, as well as their recommendations for key design elements in K-12 AI education.

3.2 Participants

This study selected 30 teachers from 10 secondary schools in China as research subjects, with 3 teachers from each school. Each teacher developed and implemented a school-based artificial intelligence teaching unit. The average age of the teachers was 38.2 years, with 14 men and 16 women. These schools were located in different provinces of China, and their socioeconomic backgrounds and academic levels varied. This study employed a qualitative research method, utilizing 12 sets of teaching materials (including lesson plans, slides, and exercises) and course meeting minutes. The authors developed a semi-structured interview method. The interviews mainly focused on the following questions:

- What content should be incorporated into AI instructional units (content approach)?
- What anticipated learning outcomes should be incorporated in the units (product approach)?
- & What are the pedagogical techniques and instructional design (process and praxis methodologies)?

3.3 Data analysis

The authors employed semi-structured interviews, utilizing teaching materials as supplementary tools within the context of four curriculum design methods, to facilitate dialogue between participants and researchers. Participants and research assistants collaboratively explored the design and instruction of AI courses, while instructors used these resources as evidence to support their concepts.

This study employed a topic analysis approach combining inductive and deductive reasoning to identify the fundamental elements of AI courses. This method effectively summarizes the key characteristics of large datasets and identifies similarities and differences, making it valuable for curriculum development within a participatory research framework (Braun & Clarke, 2006). Data analysis was conducted in four phases, based on a known theoretical framework (Braun & Clarke, 2006) to ensure the authenticity, credibility, and reliability of the data (Avenier & Thomas, 2015).

Phase 1: Analyzing Data and Generating Initial Codes. One research assistant read the text line by line, annotating it with codes to describe key content.
Phase 2: Identifying Topics. Another research assistant reviewed all annotated text, carefully examining the codes and identifying any discrepancies in interpretation. Another research assistant acts as a mediator, resolving any disagreements on interpretation. The team analyzes the coding to generate initial topics.
Phase Three: Topic Review. The team groups some topics together and breaks down others into subtopics. This process is repeated until the researchers are satisfied with the topic map.
Phase Four: Defining and Naming Topics. Topic names indicate their characteristics and importance.

4. RESULTS AND DISCUSSION

Theme 1: Expertise in Artificial Intelligence: What constitutes artificial intelligence? What are the most recent advancements?
In this subtheme, all the educators acknowledged that AI technologies have become integral to society, and thus, their students would be users of AI. Understanding of AI should encompass its definition and evolution.
1.1 Definition of Artificial Intelligence. The majority of educators used the following definition: “AI denotes the capacity of a machine to execute tasks analogous to human learning and decision-making.” Students must comprehend the fundamental principles of how AI systems utilise data to enhance their capabilities, encompassing modelling, statistical inference, and learning algorithms. Cloud computing is essential for processing vast quantities of data to enhance the training of models and algorithms.
1.2 Advancement of artificial intelligence. The majority of educators said that kids ought to comprehend the history of AI and its recent advancements, including the "fourth industrial revolution," and how AI transforms the fundamental notion of machine labour, as illustrated in Fig. 3. All of the educators asserted that "data constitute the new code." For instance, non-AI robots are designed to address human issues using predefined rules or algorithms, but AI machines utilise data to formulate and refine rules or models. All teachers concurred that students must be able to discern whether the technologies they utilise are AI and recognise their implications, as these technologies are often embedded in daily life, encompassing business, entertainment, mobile devices, social media, online assistance, and biometric recognition. Consequently, the incorporation of AI technologies into our daily life must be recognised.
Theme 2. Mechanisms in AI: How Do Various AI Technologies Function?
Our examination of this subtheme indicated that, for AI processes, both perception and technical abilities must be incorporated in the instruction of AI technology. Comprehending the mechanics of AI can motivate students to pursue careers as AI developers and/or researchers.
2.1 Perception. The investigation indicated that "human learning and decision-making" constitute fundamental AI knowledge, since machines interpret our environment through data collection. Perception is the capacity to organise, recognise, and interpret sensory input, enabling comprehension and representation of data. Students must comprehend the mechanisms by which AI systems analyse data, encompassing visual, auditory, cognitive, creative, or logical elements, through experiential learning, interaction, and programming. This corroborates the research conducted by Chiu et al. (2021) and Touretzky (2020), which underscores the significance of AI perception.
2.2 Proficiencies in technical competencies. Artificial Intelligence encompasses far more than mere programming. Students must possess the ability to execute mathematical operations and develop classifiers or models utilising machine learning libraries, as well as have a fundamental understanding of neural networks. For instance, students have developed AI programs for hand gestures (Fig.1). This corroborates the findings of Chiu et al. (2021) and SenseTime (2018), underscoring the significance of engineering methodologies, specifically AI technical competencies.

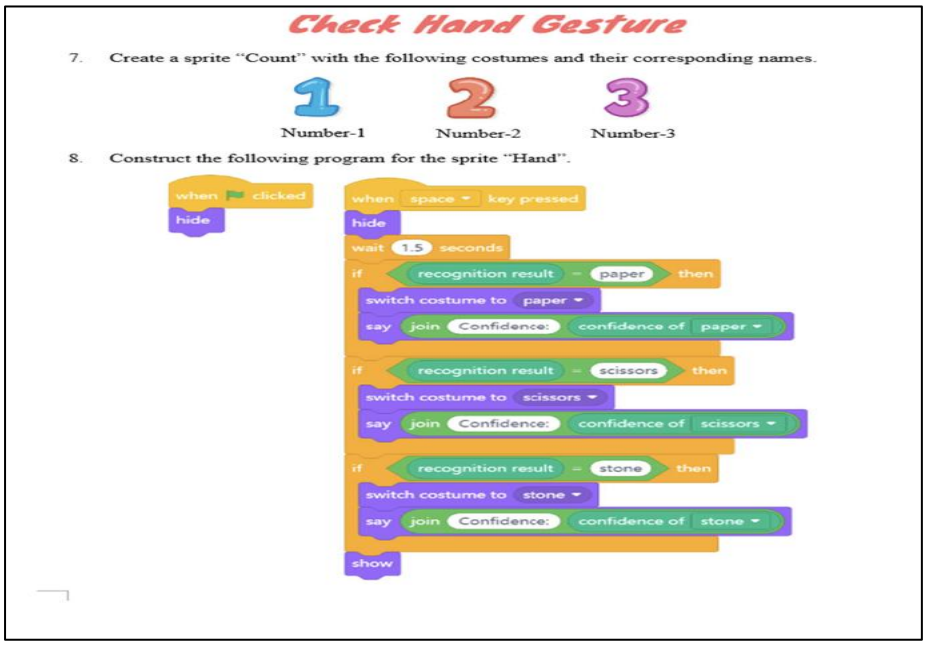

Fig.1. Teacher–Student Communication: How Do Teachers/Teaching Materials Communicate with Students?

Theme3. Impact: The Effects of AI Technologies on Society and Daily Life

The final subtheme in Theme 1 indicates that the educators proposed that the domains of societal effect and AI ethics, together with human bias, should be incorporated into AI ethical design research. These are significant subjects in K-12 education.

3.1 Societal influence. The investigation indicated that all teaching resources included this topic. AI technologies address real-world issues for us daily and possess the power to transform each encounter into a continuous learning experience (Shubhendu & Vijay, 2013). AI technologies have exerted both detrimental and beneficial effects on global, social, and individual levels, including transformations in the future workforce and advancements in societal conditions.

3.2 Ethics of artificial intelligence and human prejudice. The investigation indicated that all teachers incorporated this topic and proposed it as an additional core knowledge area. The objective is to educate students to become ethical designers. Nonetheless, AI technology deemed ethical by computer experts may be perceived as unethical by users.

For instance, "Google rectified its biassed algorithm by eliminating gorillas from its image-labeling technology." (BBC, 2015). Students ought to evaluate ethical concerns from the standpoint of stakeholders, including developers, policymakers, and users. They must not only examine these concerns from various viewpoints but also establish rules for the ethical design and implementation of AI-based technology.

5. CONCLUSION AND LIMITATIONS

New AI education methods in schools emphasise recognising AI content, tools, technical abilities, and thinking. However, without considering student learning and teacher-student interactions, these may not adequately prepare pupils for a society with pervasive AI.Developing an AI curriculum is tough, especially for K-12 general education. Besides content and outcomes, this study addressed varied student and school needs and interests, proposing two themes and six essential design components (i.e., six sub-themes). Teachers must navigate mediating curriculum policies to assure student achievement in K-12 AI curriculum design and implementation (Simmons & MacLean, 2018).

Policy mediation and practice development are necessary to meet local requirements (Priestley, 2011). This study suggests a model for K-12 schools and teachers to develop unique AI curricula to meet student needs. Three study limitations are listed. The model's main limitation is its lack of field testing. To explore its potential, invite various schools (e.g., urban, suburban, gifted, mainstream, and special education needs) to apply the model in curriculum design and implementation.

Second, the study used teacher perspectives and teaching materials to gather data. Future studies should include student and society viewpoints to enhance findings and inform AI education. The study did not address how teacher AI teaching competence affects curriculum design and development, as most teachers did not study AI issues or obtain formal AI training. Future research should examine how AI teacher professional programs impact curriculum design and development.

REFERENCES

1. Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives: complete edition*. Addison Wesley Longman, Inc.
2. Avenier, M. J., & Thomas, C. (2015). Finding one's way around various methodological guidelines for doing rigorous case studies: A comparison of four epistemological frameworks. *Systèmes d'information & management*, *20*(1), 61-98.
3. Bonnett, M. (2002). Education for sustainability as a frame of mind. *Environmental education research*, *8*(1), 9-20.
4. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), 77-101.
5. Chalmers, N., Gough, S., & Scott, W. (2003). *Sustainable development and learning: Framing the issues*. Routledge.
6. Chiu, T. K., & Churchill, D. (2016). Adoption of mobile devices in teaching: Changes in teacher beliefs, attitudes and anxiety. *Interactive Learning Environments*, *24*(2), 317-327.
7. Chiu, T. K., Lin, T. J., & Lonka, K. (2021). Motivating online learning: The challenges of COVID-19 and beyond. *The asia-pacific education researcher*, *30*(3), 187-190.
8. Chiu, T. K. (2024). Future research recommendations for transforming higher education with generative AI. *Computers and education: Artificial intelligence*, *6*, 100197.
9. Chiu, T. K., & Hew, T. K. (2018). Factors influencing peer learning and performance in MOOC asynchronous online discussion forum. *Australasian Journal of Educational Technology*, *34*(4).
10. Chiu, T. K., & Chai, C. S. (2020). Sustainable curriculum planning for artificial intelligence education: A self-determination theory perspective. *Sustainability*, *12*(14), 5568.
11. Dai, Y., Liu, A., Qin, J., Guo, Y., Jong, M. S. Y., Chai, C. S., & Lin, Z. (2023). Collaborative construction of artificial intelligence curriculum in primary schools. *Journal of engineering education*, *112*(1), 23-42.
12. Glatthorn, A. A., Boschee, F., Whitehead, B. M., & Boschee, B. F. (2018). *Curriculum leadership: Strategies for development and implementation*. SAGE publications.
13. Grundy, S. (1987). Curriculum: Product or praxis?.
14. Guion Akdağ, E., & Swanson, D. M. (2018). Ethics, power, internationalisation and the postcolonial: A Foucauldian discourse analysis of policy documents in two Scottish universities. *European Journal of Higher Education*, *8*(1), 67-82.
15. Kelly, A. (2009). The curriculum: Theory and practice.
16. Kooli, C. (2023). Chatbots in education and research: A critical examination of ethical implications and solutions. *Sustainability*, *15*(7), 5614.
17. Lebow, D. (1993). Constructivist values for instructional systems design: Five principles toward a new mindset. *Educational technology research and development*, *41*(3), 4-16.
18. Ng, D. T. K., Tan, C. W., & Leung, J. K. L. (2024). Empowering student self-regulated learning and science education through ChatGPT: A pioneering pilot study. *British Journal of Educational Technology*, *55*(4), 1328-1353.
19. Priestley, M. (2011). Whatever happened to curriculum theory? Critical realism and curriculum change. *Pedagogy, culture & society*, *19*(2), 221-237.
20. Simmons, J., & MacLean, J. (2018). Physical education teachers' perceptions of factors that inhibit and facilitate the enactment of curriculum change in a high-stakes exam climate. *Sport, Education and Society*, *23*(2), 186-202.
21. Simunovic, N., Devereaux, P. J., Sprague, S., Guyatt, G. H., Schemitsch, E., DeBeer, J., & Bhandari, M. (2010). Effect of early surgery after hip fracture on mortality and complications: systematic review and meta-analysis. *Cmaj*, *182*(15), 1609-1616.
22. Swanson, D. M., & Gamal, M. (2021). Global Citizenship Education/Learning for Sustainability: Tensions,'flaws', and contradictions as critical moments of possibility and radical hope in educating for alternative futures. *Globalisation, Societies and Education*, *19*(4), 456-469.
23. Tapalova, O., & Zhiyenbayeva, N. (2022). Artificial intelligence in education: AIEd for personalised learning pathways. *Electronic Journal of e-Learning*, *20*(5), 639-653.
24. Xia, Q., Chiu, T. K., Lee, M., Sanusi, I. T., Dai, Y., & Chai, C. S. (2022). A self-determination theory (SDT) design approach for inclusive and diverse artificial intelligence (AI) education. *Computers & education*, *189*, 104582.