Artificial Learning Companions and Social Impact of AI in Education

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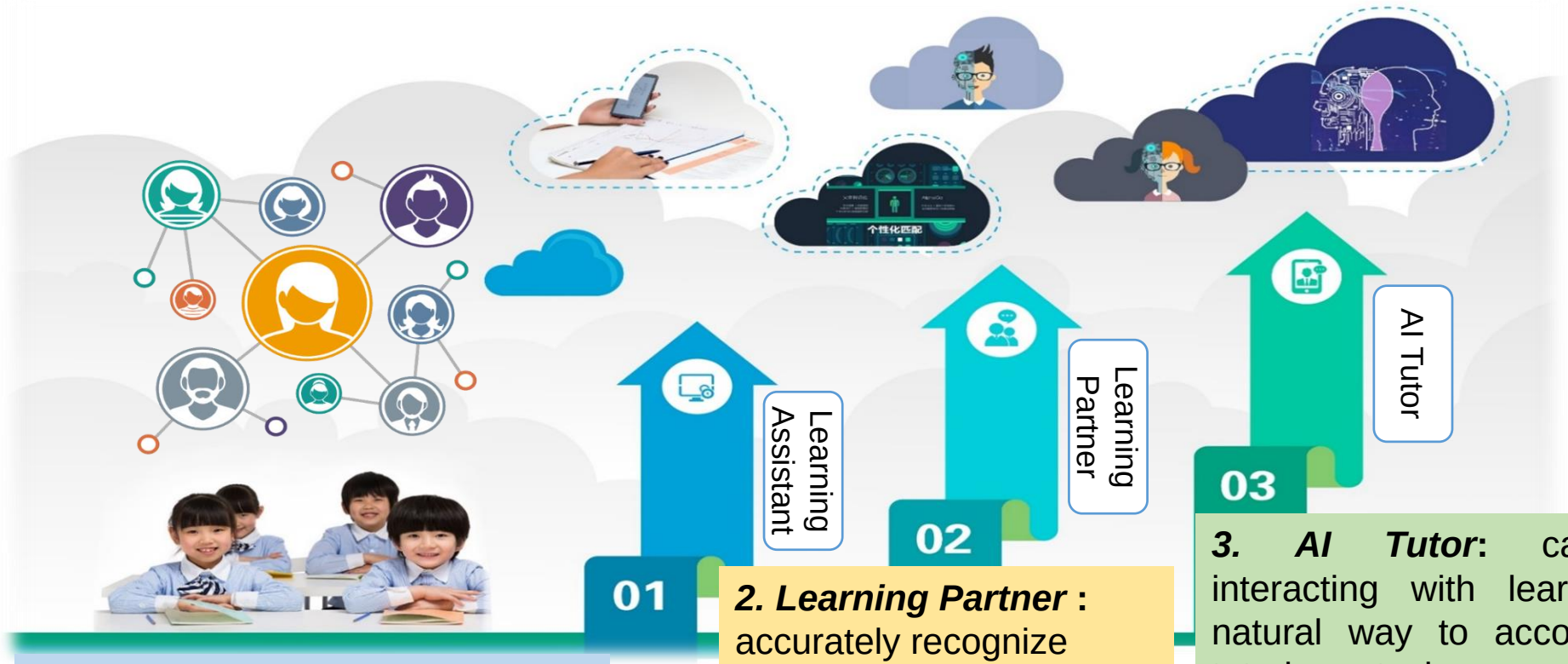
Three-Step Research Plan for AI Companions



1. Learning Assistant: Capture and understand the demands from learners and then recommend learning resources.

2. Learning Partner : accurately recognize learners' knowledge and emotion status, and then serve as a partner to increase interests and engagement of learners.

3. AI Tutor: capable of interacting with learners in a natural way to accomplish the tutoring tasks conducted by human teachers.

Case 1: AI-Powered Intelligent Tutoring System (ITS)

RadarMath System

- Driven by the new structure of ITS and the latest AI techniques for math education.
- New design for learner model, user interface, pedagogical strategy model and domain knowledge model .
- Provide learners personalized learning guidance and automatic diagnosis service.

A Short Video Demo of Radar Math
https://www.youtube.com/watch?v=b4Jb39pRsxA

Yu Lu, Yang Pian, Penghe Chen, Qinggang Meng, Yunbo Cao, "RadarMath: An Intelligent Tutoring System for Math Education", AAAI Conference on Artificial Intelligence (AAAI), 2021.

Case 1: AI-Powered Intelligent Tutoring System (ITS)

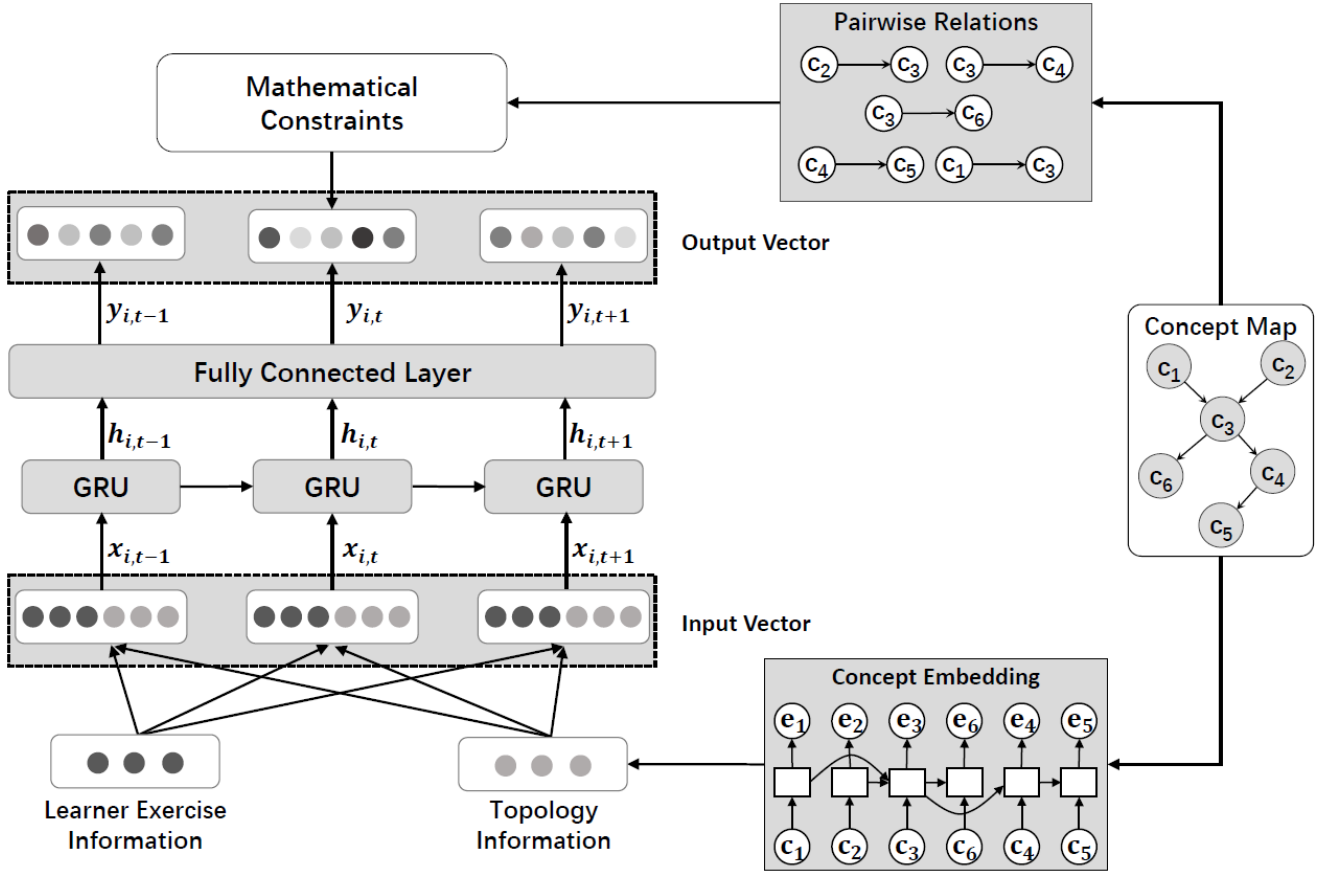
Learner Model

CMKT Model. Considering the model output $a_{i,t}$ described above and the *ordering pair* defined in Eq. 1, we propose the objective function for the CMKT model as:

$$\max_{\Theta} \prod_{i} \prod_{t} P(a_{i,t}|\mathbf{s}_i, \Theta)$$

$$s.t., P(y_{i,t,k'} = 1) \leq P(y_{i,t,k} = 1), \ \forall \ (k, k') \in \mathcal{E}, \ \forall u_i \in \mathcal{U}, \tag{9}$$

where $\Theta = \Theta_c \cup \Theta_s \cup \{\mathbf{W}_y, \mathbf{b}_y\}$ denotes the internal parameter set, and the hard mathematical constraints are derived from the educational relations in concept map, where $(k, k') \in \mathcal{E}$ denotes the pairwise prerequisite relations.

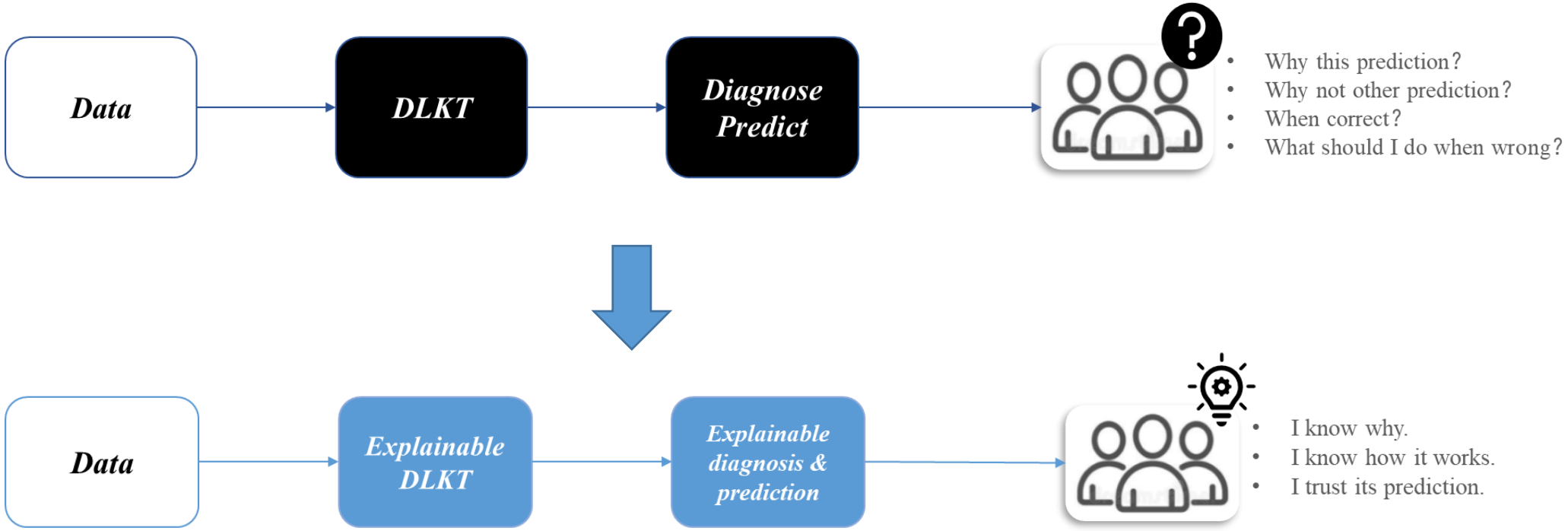


Yu Lu, Penghe Chen, Yang Pian, Vincent W. Zheng, "CMKT: Concept Map Driven Knowledge Tracing". *IEEE Transactions on Learning Technologies* (**TLT**), 2022, 15(4): 467-480.

Case 1: AI-Powered Intelligent Tutoring System (ITS)

Limitations

- ✓ The decision process of DLKT is normally intransparent .
- ✓ Unable to provide a direct and clear explanation to the model outputs.
- ✓ Painfully impedes the large scale deployment of DLKT models in practice.



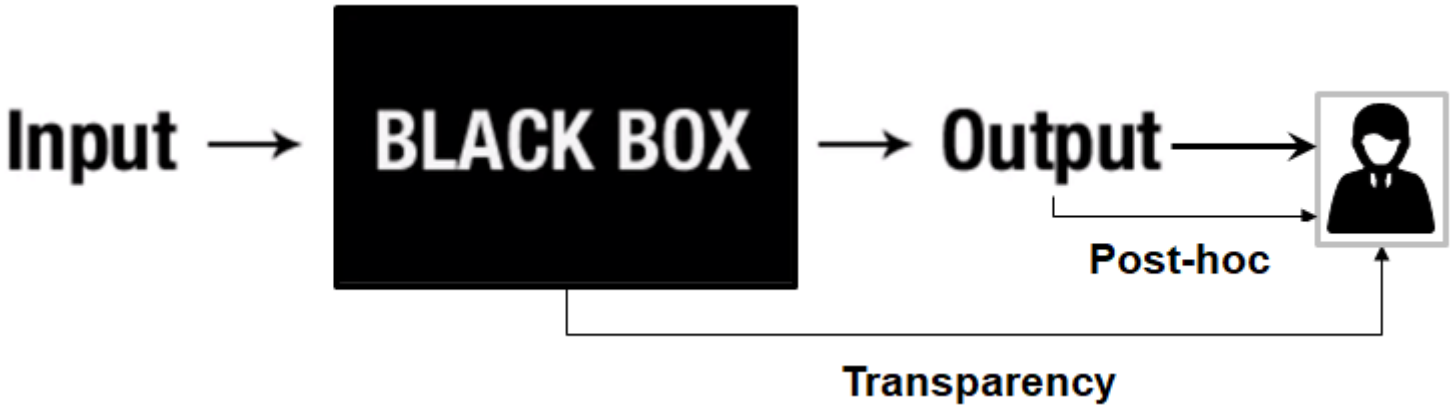
Yu Lu, et al, "Interpreting Deep Learning Models for Knowledge Tracing". International Journal of Artificial Intelligence in Education (IJAIED), 2023, 33: 1-24.

Case 1: AI-Powered Intelligent Tutoring System (ITS)

Solution to Explain DLKT Models

Solution

Introduce the explainable AI (xAI) techniques to interpret the DLKT model's outputs and even its inner working mechanism.



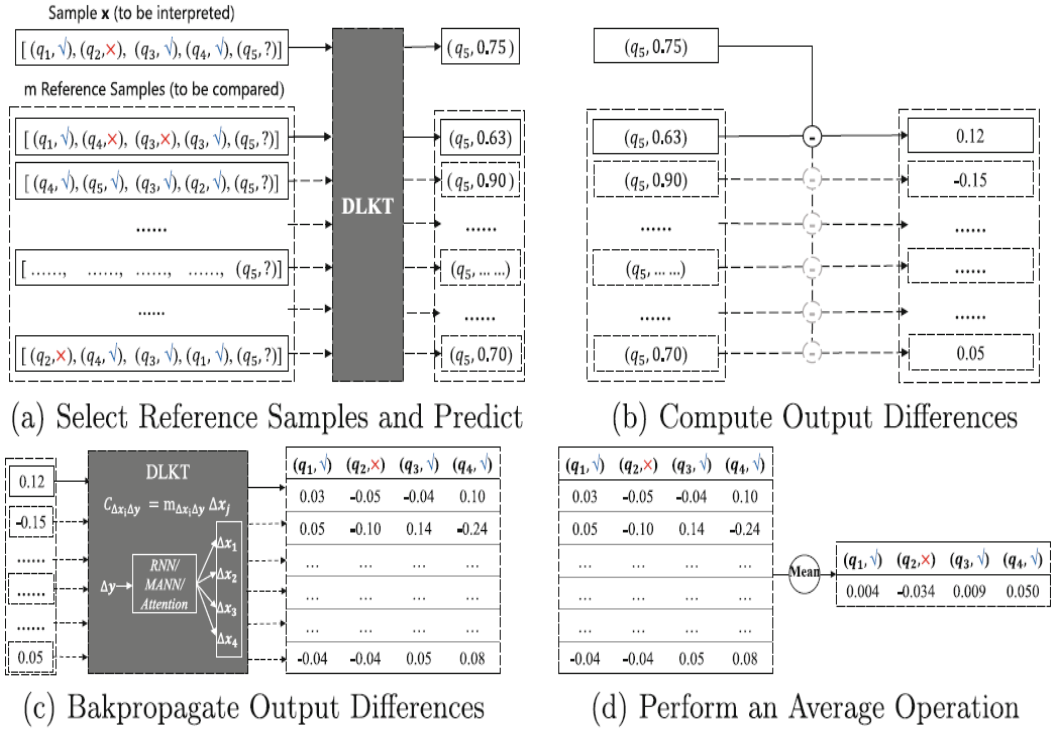
xAI Method

We adopt the **post-hoc method** to interpret DLKT models, which means given a DLKT model's decision, the local method analyzes the contributions of input variable's features to explain why the model give such a decision.

Yu Lu, et al, "Interpreting Deep Learning Models for Knowledge Tracing". International Journal of Artificial Intelligence in Education (IJAIED), 2023, 33: 1-24.

Case 1: AI-Powered Intelligent Tutoring System (ITS)

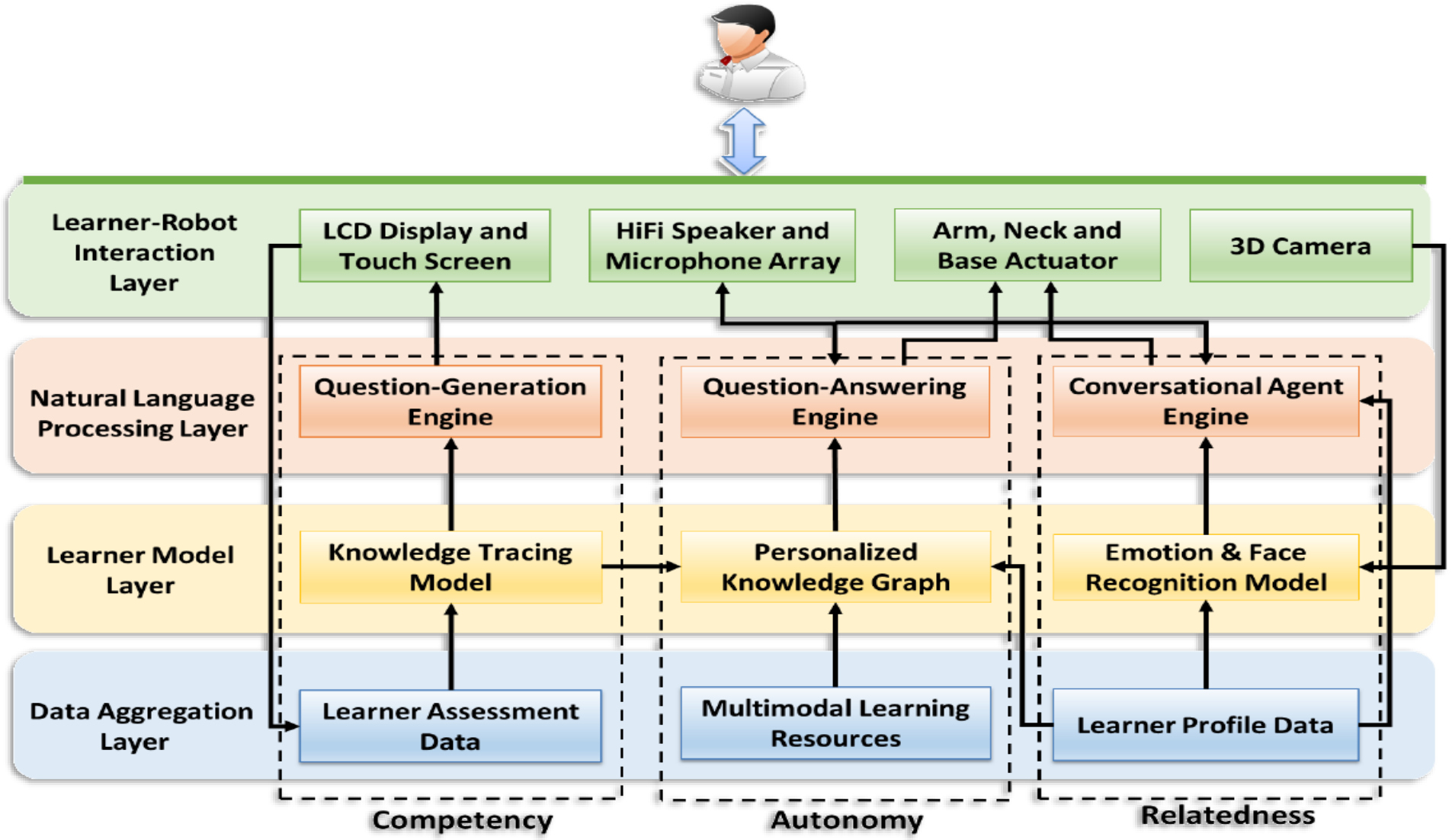
Trustworthy User Interface Design



xAI Approaches

Yu Lu, et al, "Interpreting Deep Learning Models for Knowledge Tracing". International Journal of Artificial Intelligence in Education (IJAIED), 2023, 33: 1-24.

Case 2: AI-Powered Social Robot Framework and Implementation



Yu Lu, et al., "Designing Social Robot for Adults Using Self-Determination Theory and AI Technologies," *IEEE Transactions on Learning Technologies* (**TLT**), 2023, 16(2): 206-218.

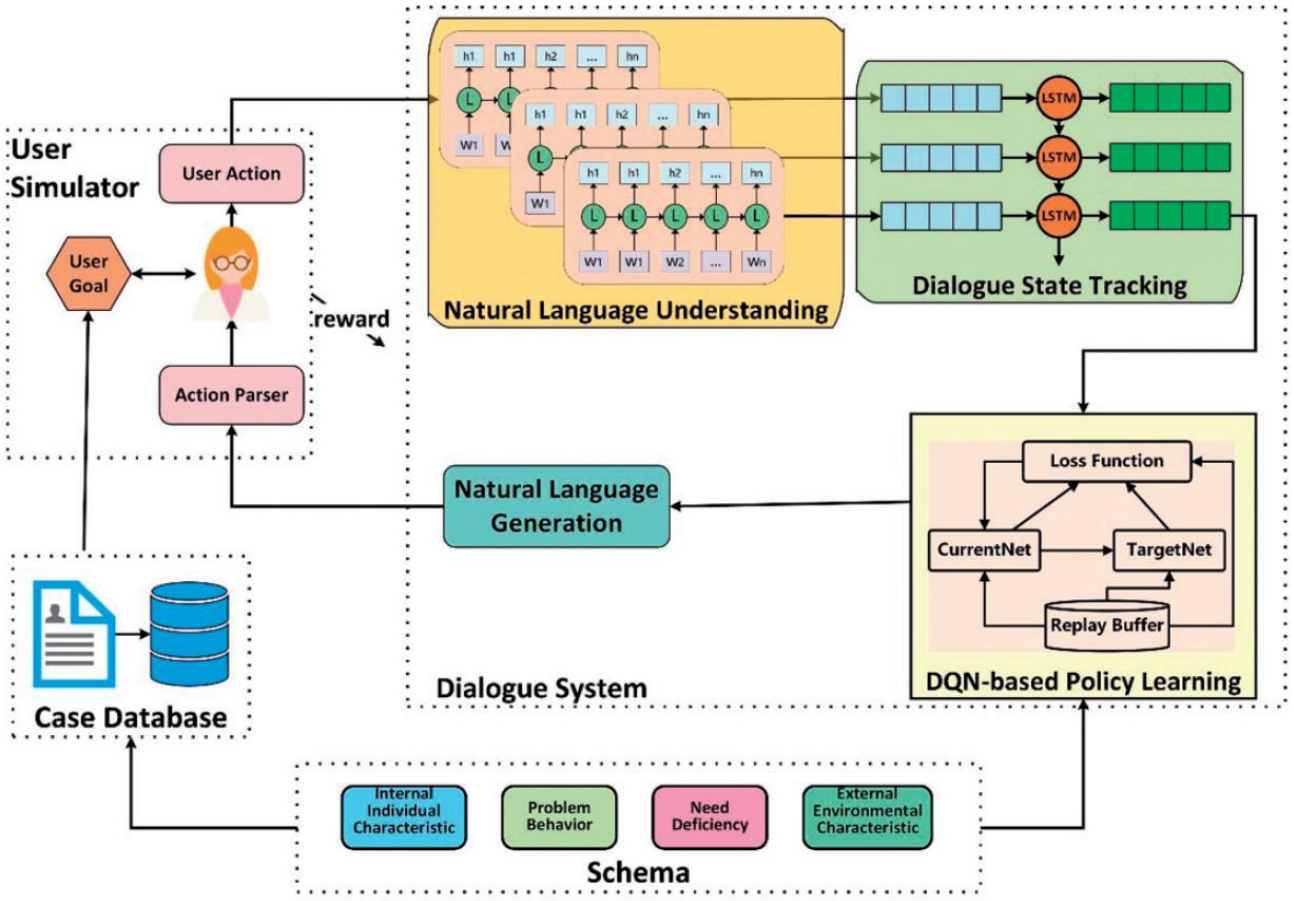
Case 2: AI-Powered Social Robot Framework and Implementation

(a) Social Robot in the Experiment Group

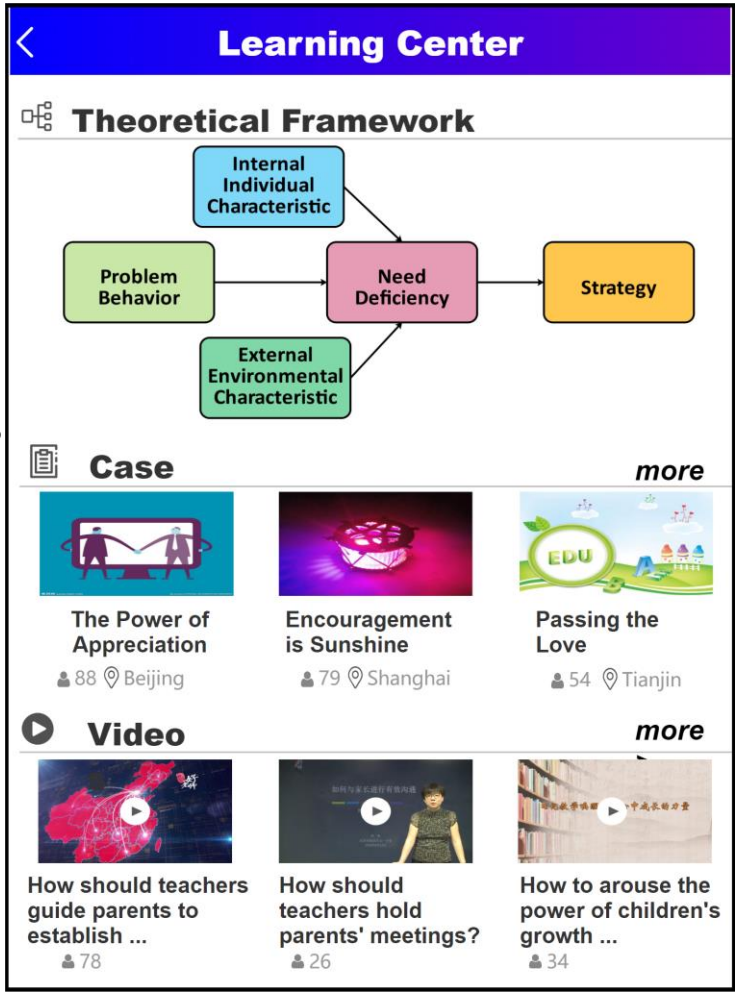
(b) Social Robot in the Control Group

Yu Lu, et al., "Designing Social Robot for Adults Using Self-Determination Theory and AI Technologies," *IEEE Transactions on Learning Technologies* (**TLT**), 2023, 16(2): 206-218.

Case 2: AI-Powered Social Robot Framework and Implementation



NLP Techniques



Penghe Chen, **Yu Lu**, et.al. "A dialogue system for identifying need deficiencies in moral education", Journal of Pacific Rim Psychology, vol. 15, pp 1-14, 2021.

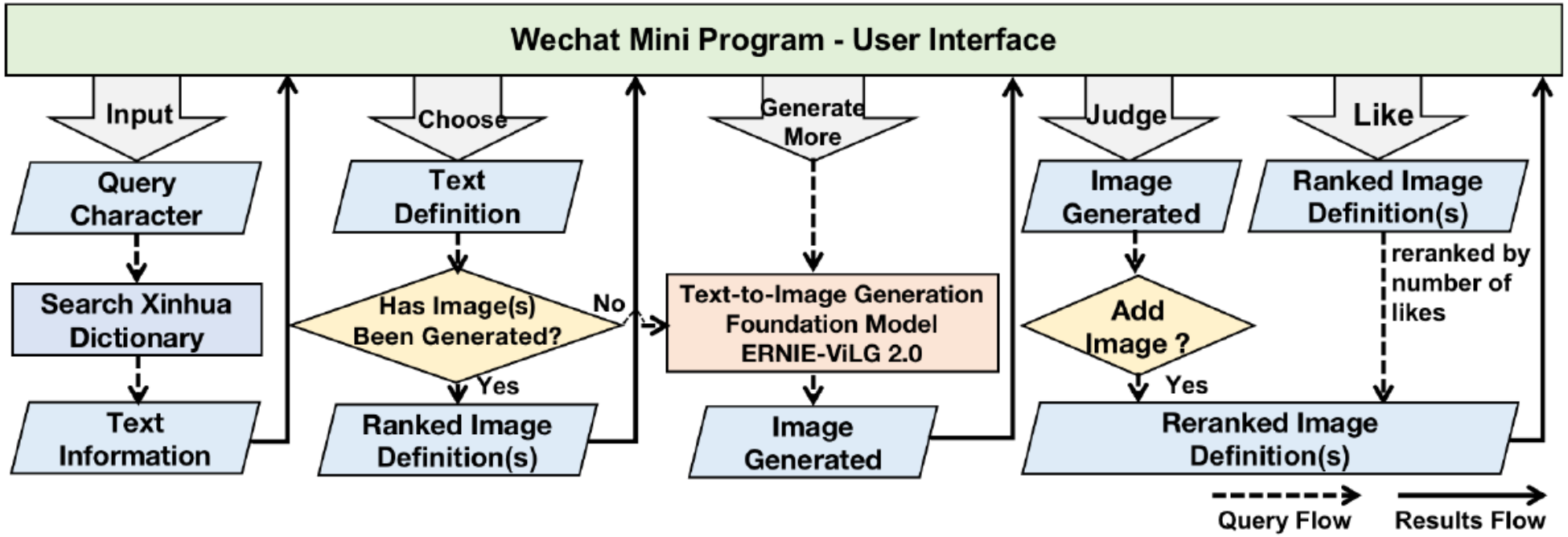
Case 3: Language Learning Partner with Generative AI Models

(a) Generated images of Definition 2 of character "Yuan" queried by description only.

(b) Generated images of Definition 2 of character "Yuan" queried by both description and sample words.

(a) Surrealism (b) Conceptual Art (c) Impressionism

(d) Computer Graphic (e) Illustrator (f) Pixel Style



Jinglei Yu, **Yu Lu**, et.al. "A Multimodal Language Learning System for Chinese Character Using Foundation Model", International Conference on Educational Data Mining (EDM), 2023.

Social Impact of AI in Schools

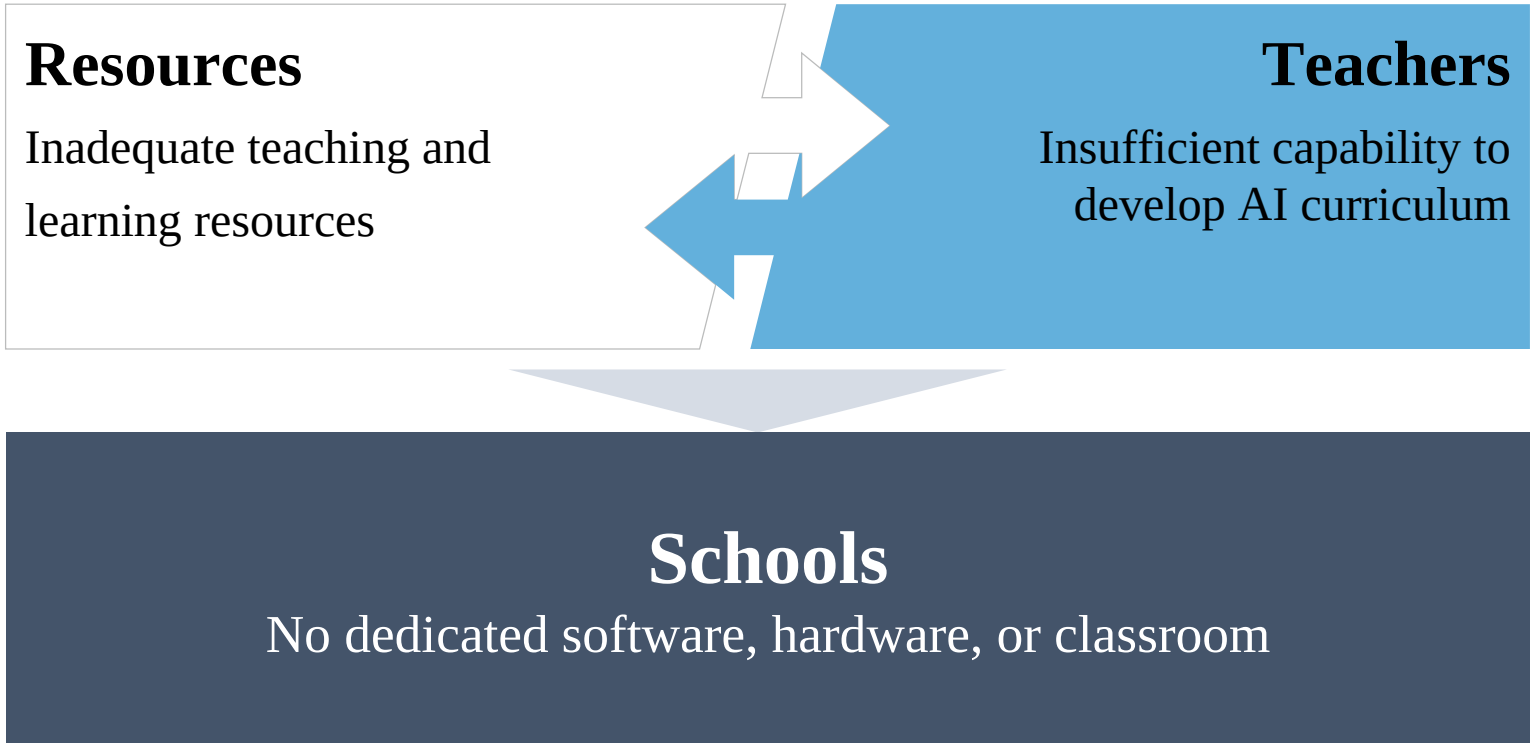
AI Education in K-12 Schools

- AI modules and the related information technology have been officially introduced into the national curriculum by ministry of education in China since April 2022.

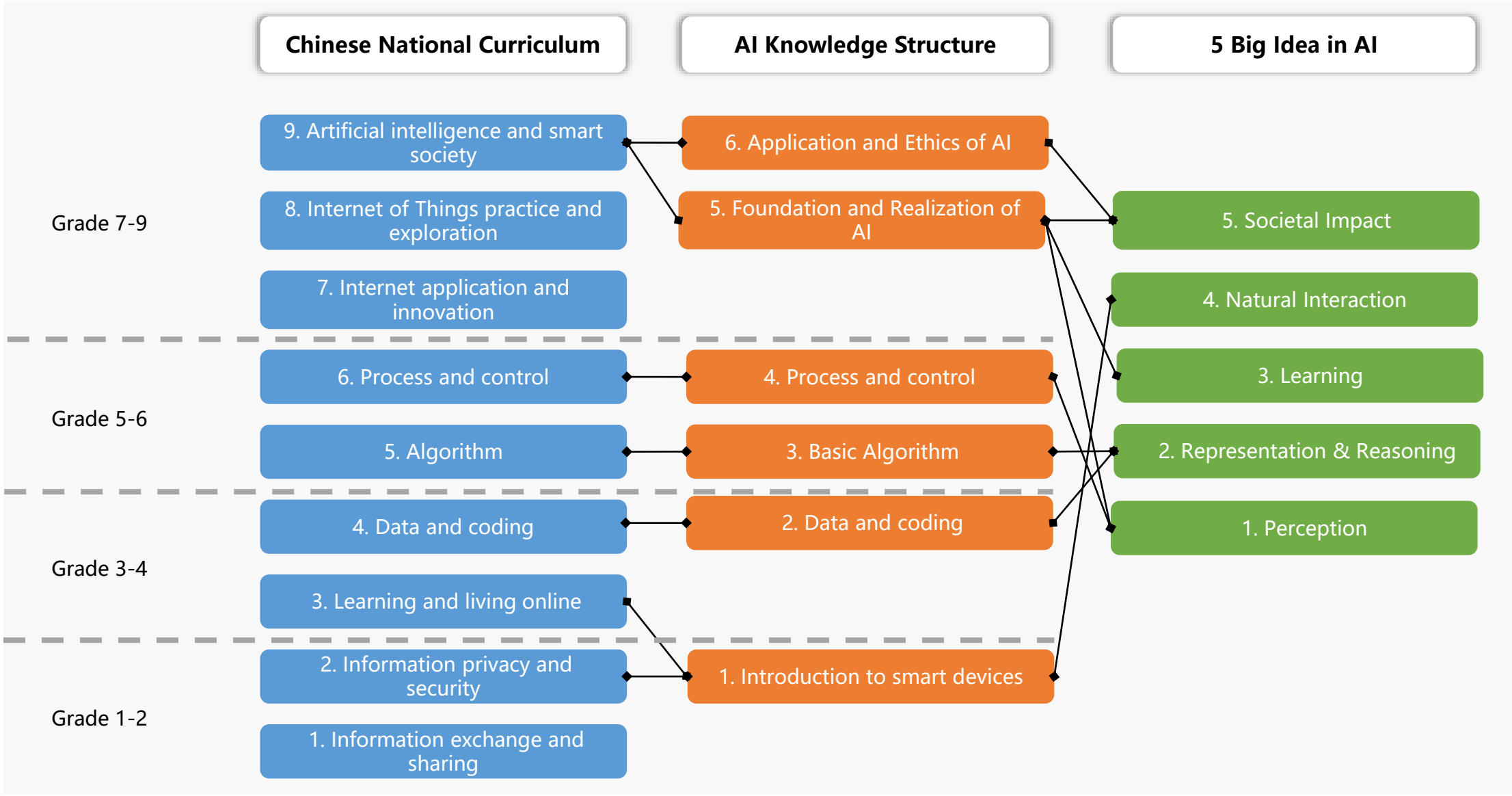
158,000,000 students in **207,200 primary and junior high schools** are supposed to take at least one class hour of information science and technology (including AI) per week.

AI Education in K-12 Schools

- Inadequate AI Resources, Teachers and Platforms.

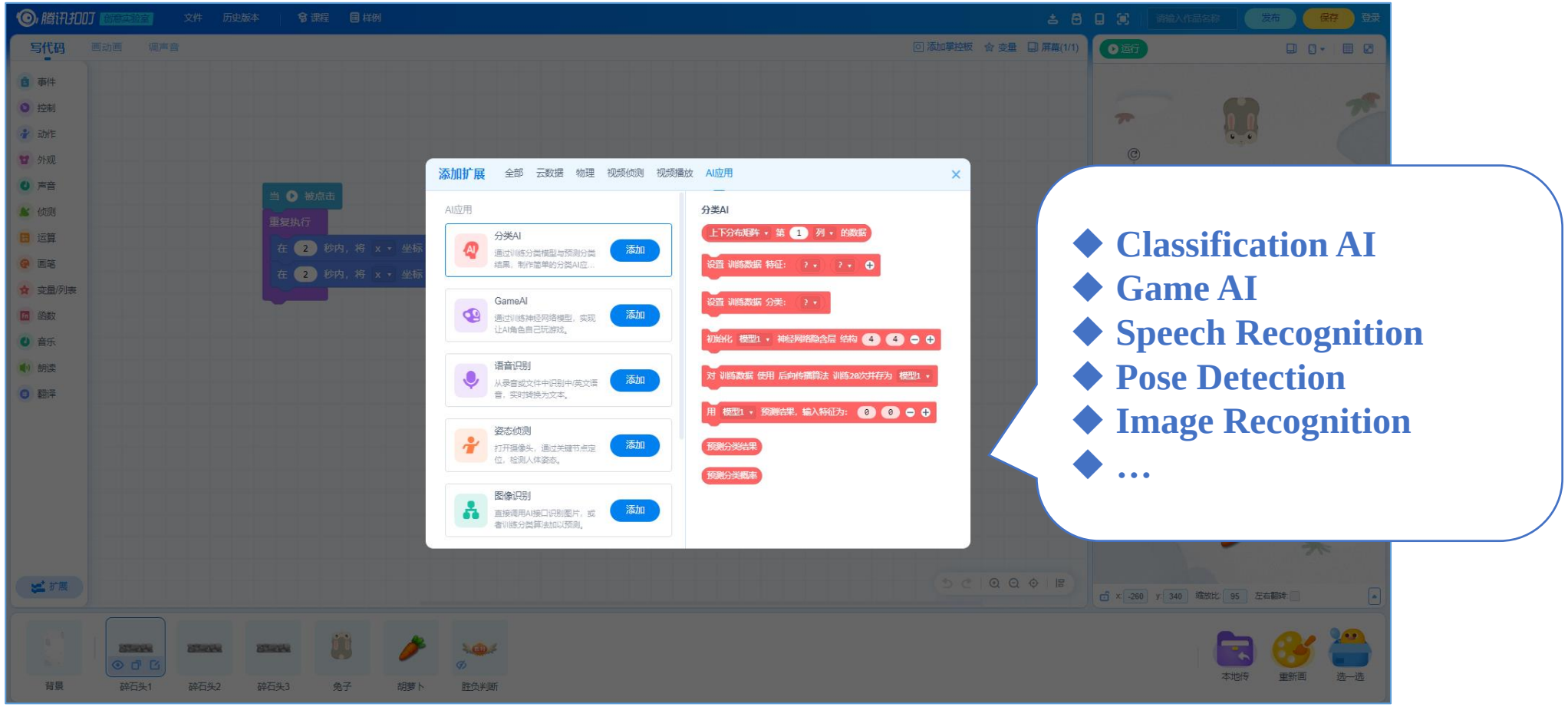


AI Education in K-12 Schools



AI Education in K-12 Schools

- Develop AI Teaching and Learning Platform



AI Education in K-12 Schools

- Develop Generative AI Teaching and Learning Resources

Multiple-choice question

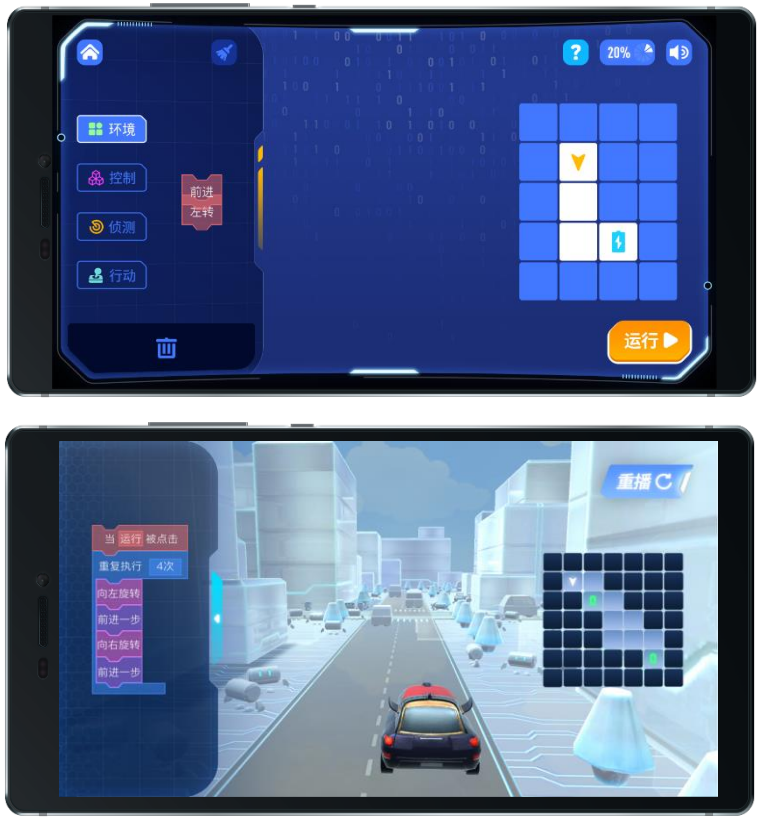
Interactive animation

Introductory Machine Learning Courses

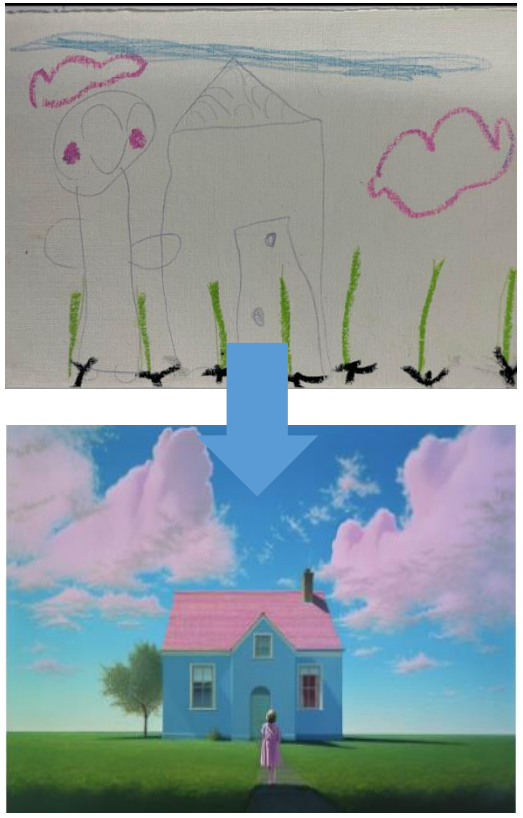
AI Education in K-12 Schools

- Develop Generative AI Teaching and Learning Resources

WeChat/QQ Mini Program



Programming with Gametech



AIGC Experience

Report

AI Education in K-12 Schools

AI Education in K-12 Schools

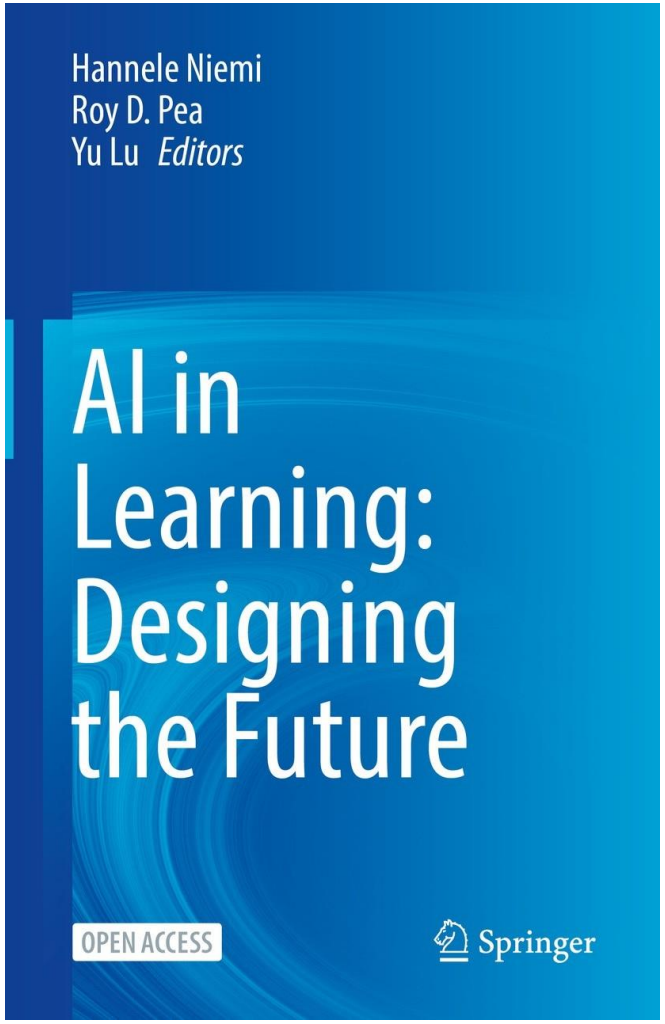
- More than 3,000 primary and secondary school teachers have been trained

More than 93% of Participants Satisfied with the Training Program

The platform is very good, which really makes more students experience AI.

There is a session for teachers to practice block-based programming.

Book Recommendation



The book mainly focuses on the latest research on AI in Learning, which includes 20 chapters within 4 parts:

- *Part I: AI Expanding Learning and Wellbeing Throughout Life*
- *Part II: AI in Games and Simulations*
- *Part III: AI Technologies for Education and Intelligent Tutoring*
- *Part IV: AI and Ethical Challenges in New Learning Environments*

It also provides pedagogical models and practices to use AI at different levels of education. The reader access number have exceeded 107,000 since it was published by Springer online in Nov. 2022.

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