CIT
互联网教育智能技术及应用
国家工程实验室

互联网教育智能技术及应用
国家工程实验室

北京師範大學
BEIJING NORMAL UNIVERSITY


清華大學
Tsinghua University


中国移动
China Mobile


网龙华渔教育


科大讯飞
iFLYTEK

UCSEC2019
US-China Smart Education Conference
University of North Texas, Denton, Texas

The Digital Transformation and Chinese Science Education

Prof. Yonghe Zheng
Beijing Normal University
2019.3.18

01 *Part One*

Science Education in China

The needs on transforming science education in China

In order to meet the needs of national development strategies, the orientation、objectives、teaching and learning methods of science education in China need to be adapted to the times with innovations and development.

Largest science and technology workforce in the world	VS.	Lack of leading talents and world-class scientists in science and technology
Fast integration of science and technology into society and daily life	VS.	Most citizens lack of basic scientific literacy

History of Chinese Science education

1900s

- Modern school system was first built in China
- 1904, released a school regulation: physics, chemistry, and nature as part of school curriculum

1978-2000

- 1978-1980s: elite oriented education system. prepare future scientists and engineers
- 1990s-2000: mass education system. foundational scientific knowledge and basic science skills

2000-now

- Curriculum reform in pursuit of quality education: scientific literacy for all students.

The world's biggest science education system

Numbers of students of formal education by Levels

Pre-school: 16,526,663

Elementary school: 15,658,999

Junior secondary school: 13,974,699

Senior secondary school: 7,796,262

Special education schools: 69,401

Undergraduate: 7,358,287

Educational Statistics in 2017 (MOE,2018)

Chinese Science Education System

Basic education

Senior secondary school (grade 10-12)	• Science: biology, physics, chemistry, earth science
Junior secondary school (grade 7-9)	• Science: biology, physics, chemistry, earth science
Elementary school (grade 1-6)	• Science
Kindergarten (pre-school)	• Science

9 year-compulsory education

Science Teacher Education

- Pre-service teacher education
  - Undergraduate courses of science education in Normal Universities : Bachelor degrees and teaching certificates
  - Pursuit teaching certificates of science education after graduated
- Professional development for in-service science teacher
  - National Teacher Training Program
  - Post-graduated degrees in universities (i.e. Masters of Education, Doctors of Education, etc.)

Development of Science Education Policy in China

2001: Reforms on National Compulsory Education Systems

National strategy

2006: Outline of the National Scheme for Scientific Literacy (2006-2010-2020)

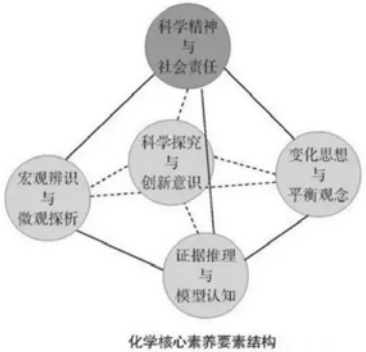
National Curriculum

2017: National science curriculum standards for the full time compulsory education (grade 1-6)

National science education standards

In 2017, MOE published national standards for science in elementary schools and science subjects in senior high schools.

Science in
Elementary school



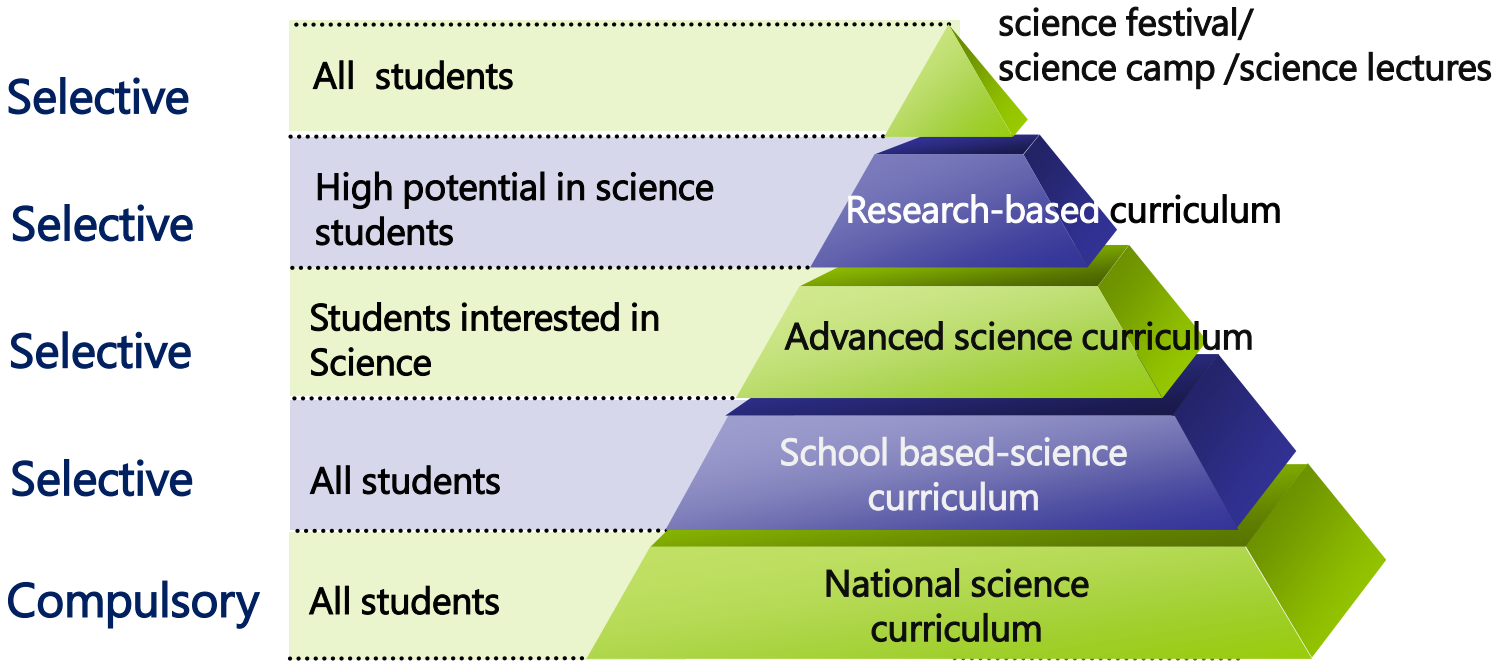
化学核心素养要素结构

Chemistry in
Junior high school

Physics in
Senior high school

The “big ideas” and “subjects core literacies” were highlighted in these new standards

Science Curriculum System: A Case in High Schools

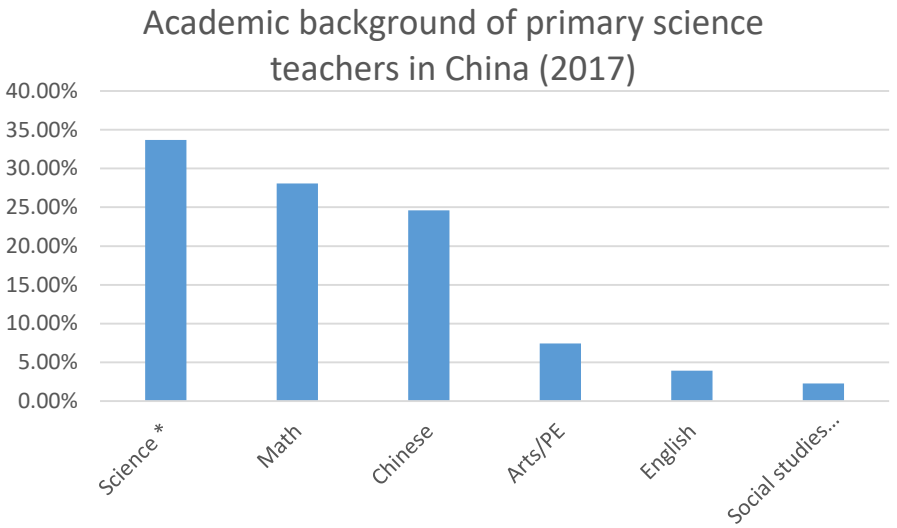


Findings：challenges of science education in Chinese schools

- Chinese students achieved good academic results in PISA (2015) but fails behind on creativity, interests on science and scientific problem solving skills.
- The college exam and other rules in educational system influenced the practices of science education in schools:
  - 32.28% students reported their science classes were once occupied by other subjects
- Unbalanced development of science education resources in schools:
  - 58.97% schools do not have science related school-based curriculum

Shortage of science teachers in China

- Only 33.68% of science teachers have science background
- 44.2% headmasters reported the unstable workforce of science teachers
- 37.3% primary schools in rural areas do not have science teachers

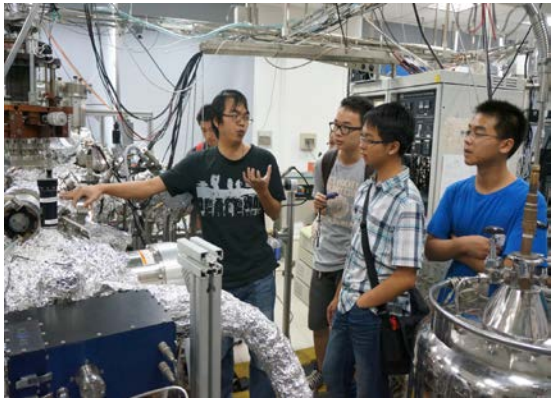


*Science includes Physics, Chemistry, Biology and Geography.

Survey conducted in 2017, received 11467 teachers' and 835 investigators and 323 parents

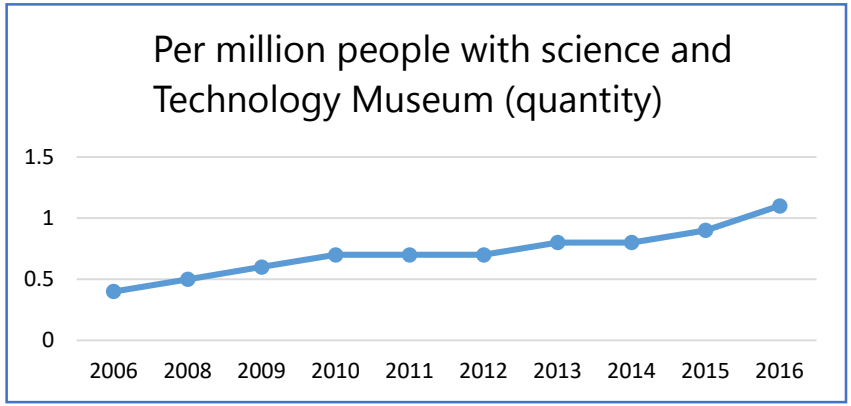
Diverse informal science education programs

- Science camps in winter and summer holidays
- Science education in science museums and botanic gardens
- STEM and Maker programs

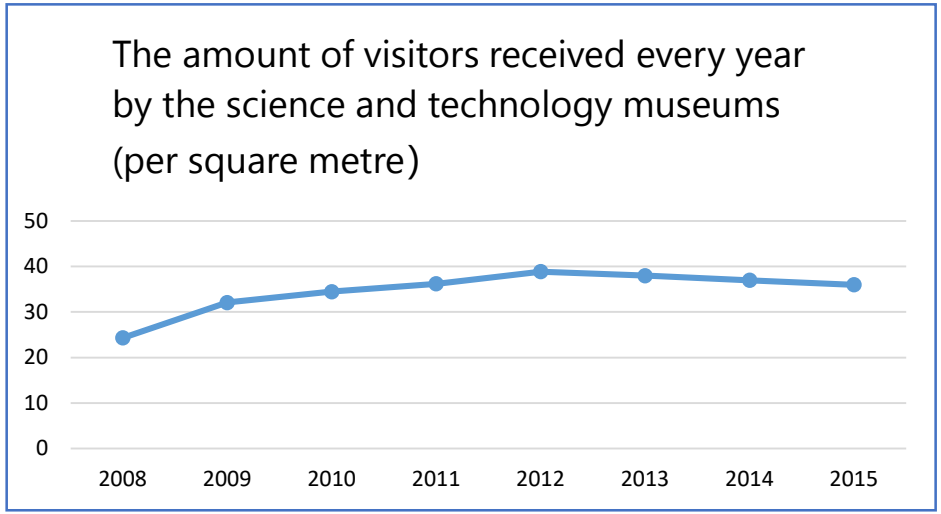


Challenge of Science education in museums

- The increase of museums and visits to museums every year
- 66.16% students without access to museums (in 2017)



http://www.gov.cn/xinwen/2017-11/27/content_5242594.htm



02 Part Two

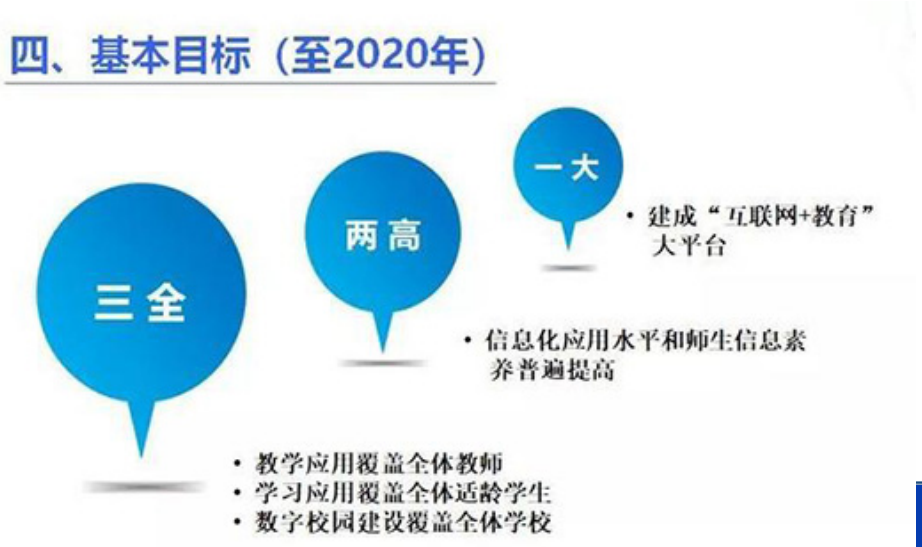
Digital Technology Application In Science Education

Policy: ICT supported educational reforms

13th April, 2018, MOE published *Educational Informatization 2.0*

To realize the transformation from dedicated resources to large resources; from improving students'information technology skills to information technology literacy; from application integration development to innovation integration development.

The object of ICT supported education in 2020



Build 1 platform:

- Internet + education platform

Improve 2 sides:

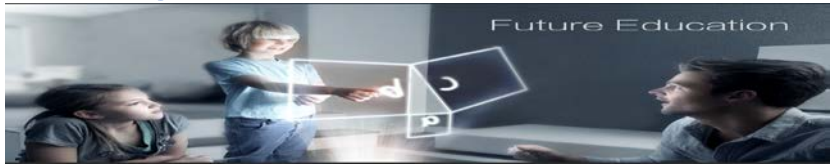
- Application of ICT in education
- Technology literacy of teachers and students

Informatization for 3 groups:

- Teaching applications for all teachers
- Learning applications for all students
- Digital schools for all schools

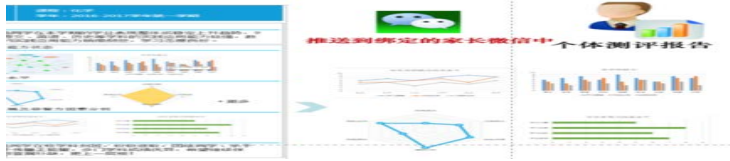
ICT supported educational reforms

Learning Environment



Adaptive learning environment and embodied cognition

Evaluations



Learning analytics supported diagnostic evaluations and personalized feedbacks

Learning and teaching objects and process

Expands the knowledge;
Transforms the way of learning

Education Management

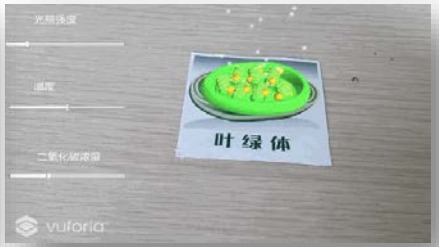
Scientific management and data-driven decision-making based on multidimensional data resources

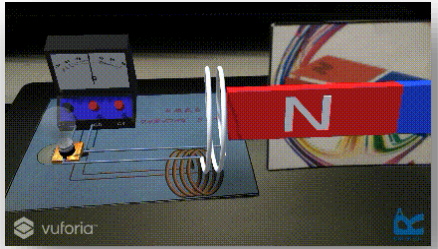
ICT supported the teaching and learning of science education in China

- Varies technologies used， with rapid increase on VR/AR
- Need to integrate ICT into daily science lessons

Scenarios	Technologies	Effects
Knowledge presentation Concept explanations Scientific inquiry Knowledge application	VR/ AR, VR Lab, 3D Visualization Mobile APPs Interactive White Board Adaptive learning	Learning interests and motivations Learning effectiveness Critical thinking Teaching efficiency

Cases of using AR in K-12 science classes





Pre-school

- Enlightenment and direct experience
- Encourage curiosity and learning interests

Elementary

- experiential and exploratory
- Promote learning interests and scientific methods

Junior Secondary

- Logical and
- Improve understanding and concept learning

Senior Secondary

- Abstract and complex
- Support scientific inquiry

ICT supported science education equity

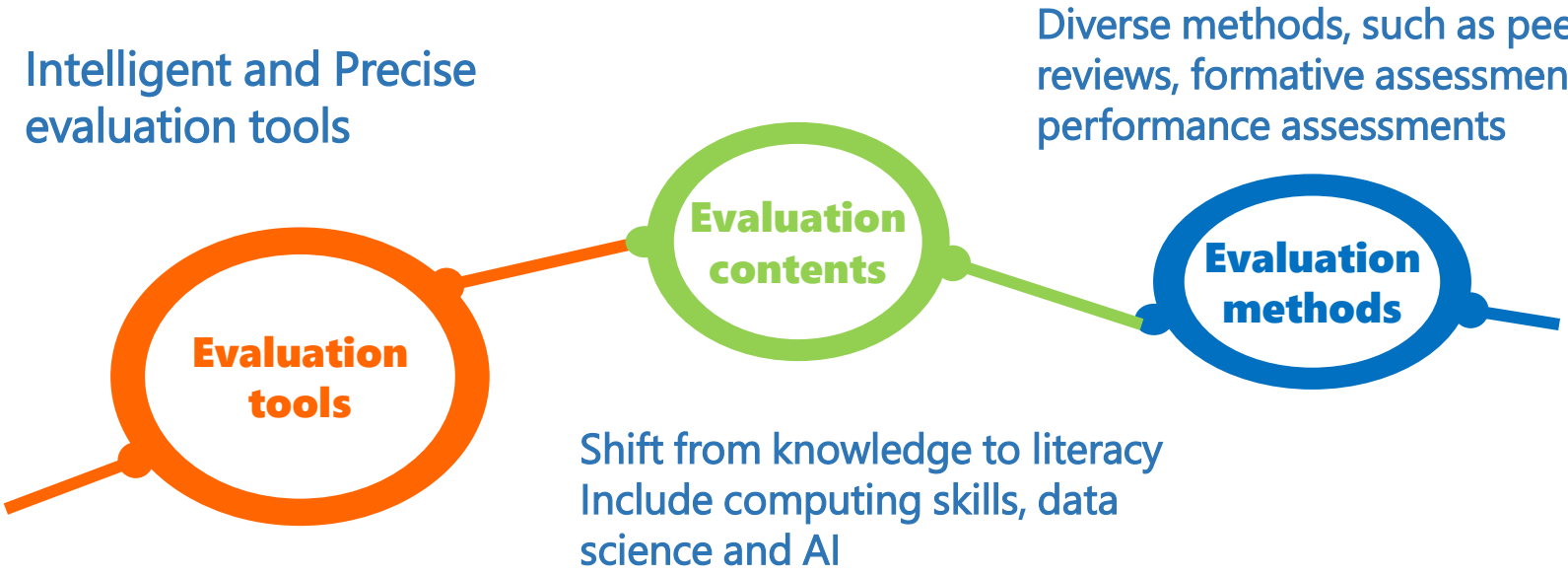
Case study of using Augmented Reality (AR) in science practical education in under-development area:

- Offer the students opportunities of “hands - on” inquiry experience
- Promote students’ learning interests and learning effectiveness

Case study 1

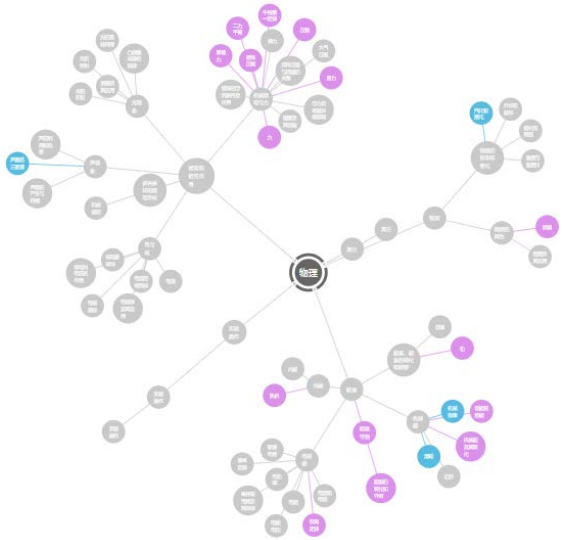
Case study 2

ICT supported evaluations in scientific education

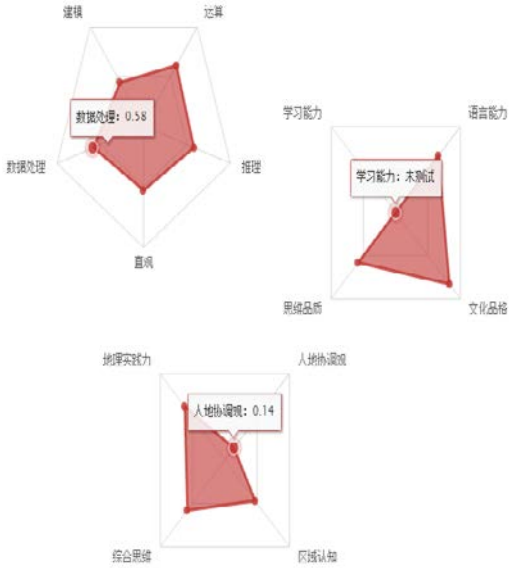


Intelligent Diagnosis and Precision Evaluation Framework

- Subjects core knowledge
- Subjects core literacy
- General Psychology and Cognitive Ability
- Physical Health

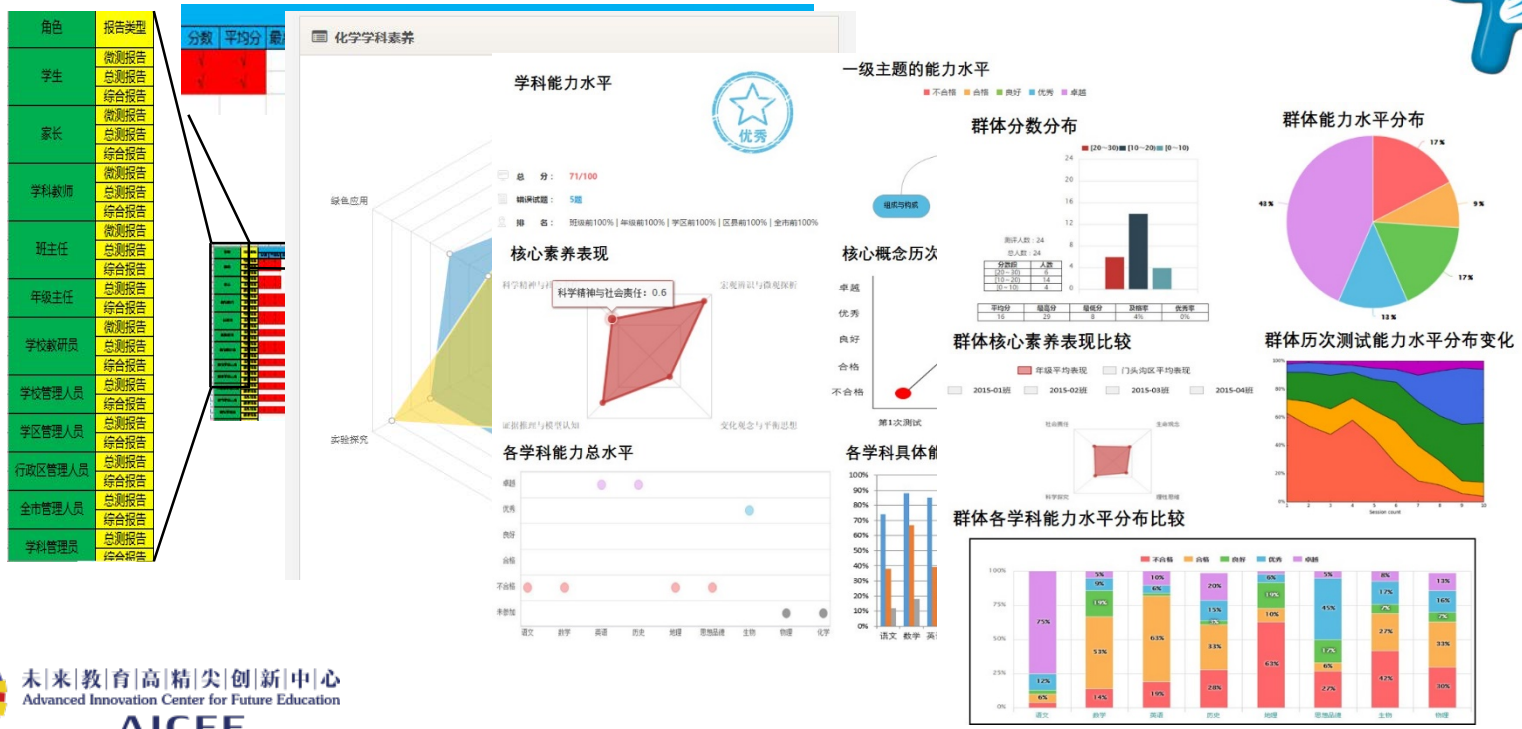


Subject Knowledge Map (example)



Subject core literacy (example)

Data-driven comprehensive and accurate evaluation



未|来|教|育|高|精|尖|创|新|中|心
Advanced Innovation Center for Future Education
AICFE

Digital divide: in Science Education

- Digital Divide: refers to the gap between people with the effective access to digital and information technology and those with very limited or no access at all.

- The unbalanced area development casts the risk of digital divide in China on science education.
  - The experiment equipment
  - The access to frontier developments of science and technology
  - The skills of using technology in science learning， etc.

03 Part Three

Science Teaching and learning in digital transformation

Digital technology transforms science T&L

Development of science and technology brings knowledge explosions

→ Science education shifts from knowledge centered to scientific literacy, including scientific methods and the nature of science.

Development of learning sciences updates the ways of teaching and learning.

→ Science classes changes from teacher-centered lectures to students-centered and inquiry-based scientific practices.

Inquiry based science teaching in China

Based on the multi-dimensional analysis on the process of scientific inquiry-based classroom teaching.

Finding 1: Shift from teacher-centered to interactive sharing

Finding 2： Lack of teachers' guidance on using scientific language

Finding 3: Taught the process of scientific inquiry without students' understanding

China	International
Teacher-centered lecture	Structured inquiry
Teacher-centered dialogical class	Guided inquiry
Interactive sharing lessons	
Authentic inquiry (open)	Open inquiry

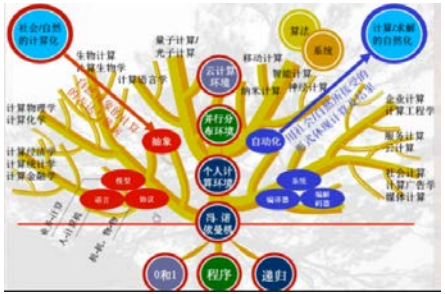
(裴新宁、郑太年等，2019，即将发表)

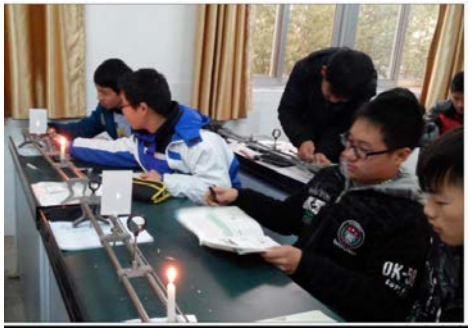
Integrate Scientific Methods into the Scientific Inquiry Lessons

Findings:

Further analysis on the use of modern scientific methods (modelling, mathematical method, computational thinking, etc.) in the inquiry classroom:

- The use of modern scientific methods in inquiry classes is generally at a lower level.
- 60% teachers use modelling in class
- 70% teachers do not use computational thinking and mathematical thinking in class



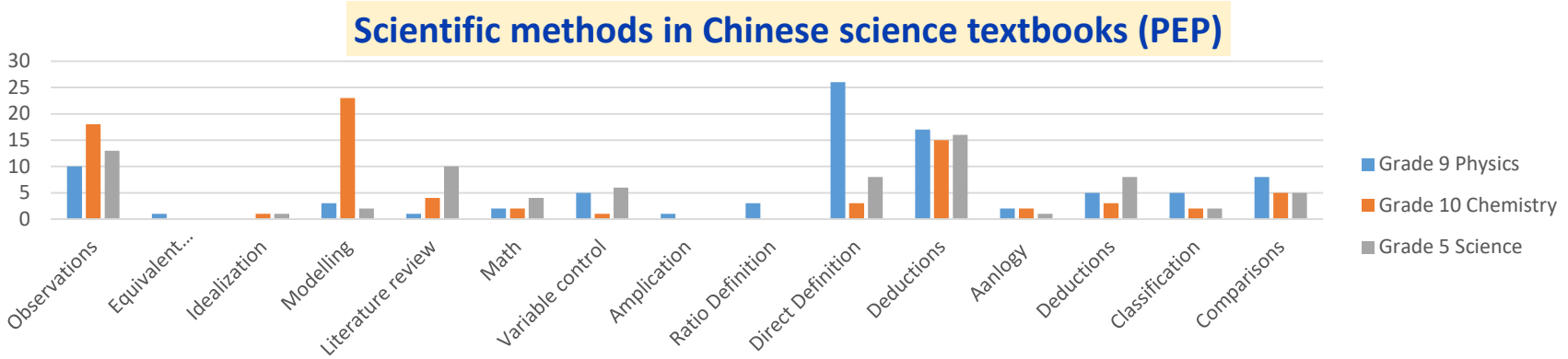


(裴新宁、郑太年等，2019，即将发表)

Scientific methods in textbooks

Findings:

- The textbooks included a variety of methods; however, the "inductions" and "observations" appeared most often.
- "Direct definition" and "Induction" occupied the most volume of Physics textbooks, which might be attributed to large amount of concepts were taught.

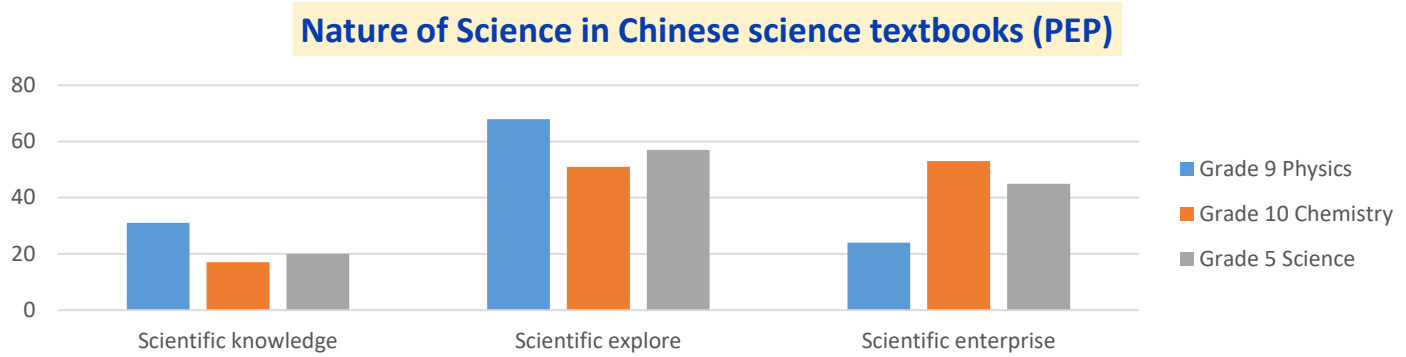


***Sample: The 3 textbooks published by PEP were analyzed in this pilot study, including science of Grade 5, Physics of Grade 9 and Chemistry of Grade 10**

Nature of Science in the Chinese science textbooks

Findings:

- Among the three dimensions of the nature of science, the nature of scientific knowledge are lest involved in the textbooks.
- Compared with the other two volumes, physics shows less about the nature of scientific enterprise and pays more attention on scientific inquiry.



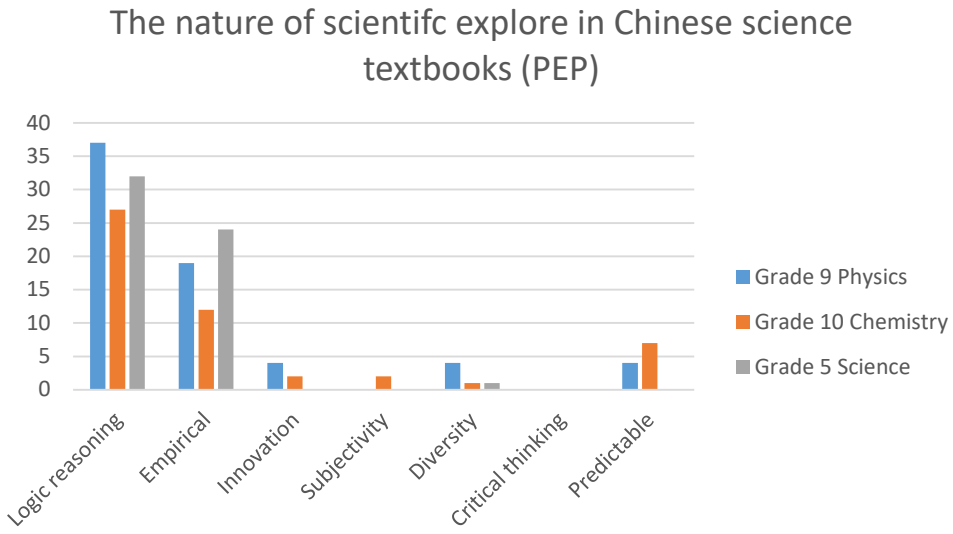
*Sample: The 3 textbooks published by PEP were analyzed in this pilot study, including science of Grade 5, Physics of Grade 9 and Chemistry of Grade 10

Nature of Science in the Chinese science textbooks

Findings:

The nature of scientific explore：

- Emphasis on Logical and empirical nature of scientific inquiry
- Lack of critical thinking and diversity of methods



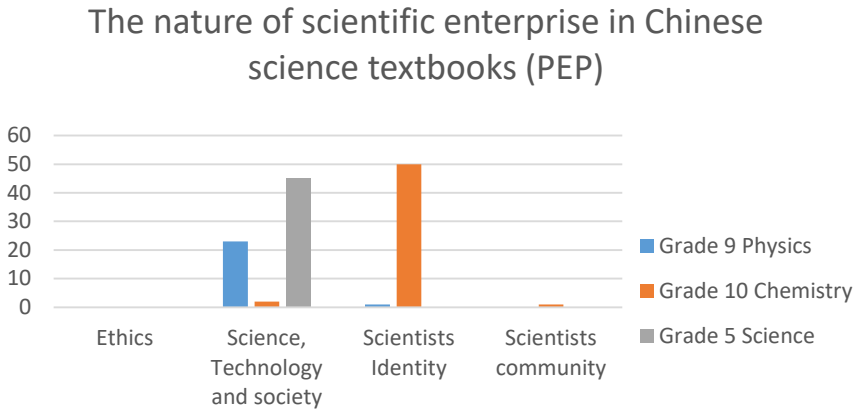
*Sample: The 3 textbooks published by PEP were analyzed in this pilot study, including science of Grade 5, Physics of Grade 9 and Chemistry of Grade 10

Nature of Science in the Chinese science textbooks

Findings:

The nature of scientific enterprise:

- Most emphasis on how S&T contribute to society, but lack of interactions among the science, technology, and the society.
- Lack of Ethics and scientific community in the textbooks



*Sample：The 3 textbooks published by PEP were analyzed in this pilot study, including science of Grade 5, Physics of Grade 9 and Chemistry of Grade 10

北京師範大學
BEIJING NORMAL UNIVERSITY

Thank You

CIT 互联网教育智能技术及应用国家工程实验室

远程教学交互研发中心

中国移动 China Mobile

知识建模与分析研发中心

清华大学 Tsinghua University

学习环境设计与评测研发中心

网龙华渔教育

科大讯飞 iFLYTEK 学习者建模与学习分析研发中心

http://cit.bnu.edu.cn

cit@bnu.edu.cn

010-58807205

北京市海淀区学院南路12号 北京师范大学南院 京师科技大厦A座3层和12层

THANKS

扫描二维码 关注公众号