Why middle school?

- Middle school education in China is considered a crucial phase as it not only lays the foundation for high school and subsequent educational pursuits but also plays a key role in determining students' eligibility for better high schools.

Nine-year Compulsary Education (since 1986)

Gaokao (College Entrance Examination)

6 years, for students aged 6-12

3 years, for students aged 15-18

| Kindergarten | Primary School | Middle School | High School | Tertiary Education |

Typically lasts for 3 years, for children aged 3-6.

3 years, for students aged 12-15

usually last for 4 years

Zhongkao (High School Entrance Examination)

Improving lives through learning

SCHOOL SYSTEM

In China

Stanford
GRADUATE SCHOOL OF EDUCATION

At this stage, students begin to learn complex science concepts that are critical to their academic success in high school and college.

Primary School

Middle School

High School

- Begins with Kindergarten at age 5.
- Continues from Grade 1 to Grade 5, ages 6 to 10.

- Covers Grade 6 to Grade 8, ages 11 to 13.
- Serves as a transitional period preparing students for high school.

- Encompasses Grade 9 to Grade 12, ages 14 to 18.
- Prepares students for college and career readiness.

Improving
lives
through
learning

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EDUCATION

TEXTBOOK

- In China, education textbooks are primarily compiled and approved by the national government.
- This means that for all subjects from elementary through high school, textbooks are authored by the Ministry of Education or its authorized agencies (such as local publishers), and are released after rigorous review.
- This also implies that most regions in China **use the same textbooks**.

CHINA
Science book

Textbook

Decentralization

- Local Control: Education in the U.S. is highly decentralized. Textbook selection and purchase are mainly decided by state and local educational institutions, not by a central government.
- School District Autonomy: At the school district level, schools even have the authority to choose textbooks themselves, as long as they meet state education department standards.

US Science textbook

Textbook

2. Diversity and Choice
- Multiple Publishers: There are many publishers competing in the market, offering different versions of textbooks. Schools can choose the ones that best fit their needs and preferences.

3. Review and Standards
- State-Level Standards: Although the choice is local, textbooks must align with state educational standards. Many states have a review process to ensure the accuracy and appropriateness of textbook content.
- Common Core State Standards: Some states follow these standards, which influence textbook content, especially in math and science.

Why China & U.S?

- **Cultural Perspective:**

- **Values and Gender Roles:**

- In China, traditional values often emphasize roles like "men work outside, women handle home," which might show up in textbooks as fewer female scientists.

- In the U.S., there's a bigger push for gender equality and showcasing individual achievements, so you might see more examples of female scientists in textbooks.

焦 耳

焦耳（James Prescott Joule，1818~1889）是国著名的实验物理学家。他从小就对实验着，在家里做起了各种实验，后来成为一名业科学家。1840 年，焦耳通过对电流的热效应研究，得出了著名的焦耳定律。焦耳定律给了电能向热能转化的定量关系。（我们将在本第 6 节中学习该定律。）

图3-31 焦耳
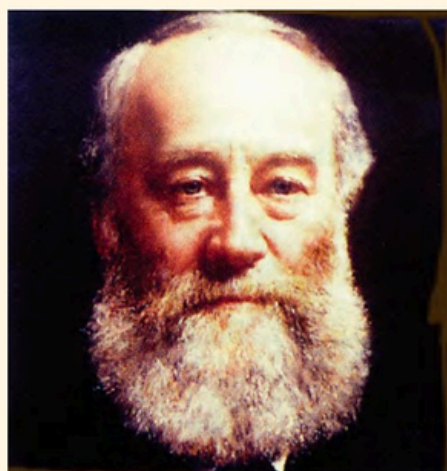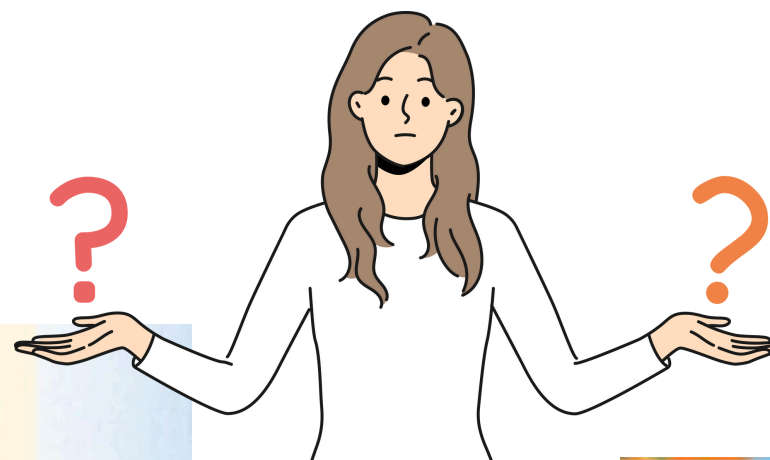
physicist

housewife

紹荣，我国卓越的科学家和教育家，
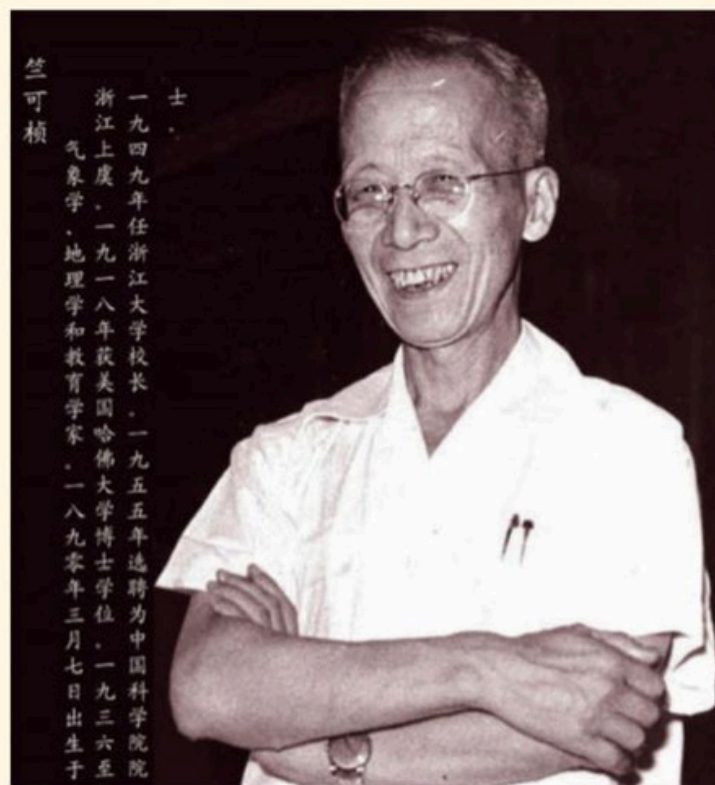
图2-55 竺可桢

basketball star   scientist   teaching child to cook

Different genders can do whatever career they want

Gather Informa

ments are ways to collect info

Laboratory investigations

Computer models

Why China & U.S?

- **Economic Perspective:**
- **Impact of Market and Policies:**
- In both countries, the market and government policies play roles in determining textbook content.
- The U.S. has a more decentralized system where market demand can quickly influence textbook content, while in China, government policies might dictate changes. Comparing these systems can help us understand different approaches to updating and improving textbook content regarding gender.

Introduction

Gender in Science Education:

- Gender issues in science education have been widely discussed over the years(Kelly 1978; Sinnes 2006; Scantlebury 2014; Morales et al. 2023).
- Notable disparities exist between boys and girls in science performance and participation(Guo et al. 2010).

Differences:

- In China, traditional views and gender discrimination affect women's participation in science (Guo et al. 2010).
- In the U.S., despite more women in science, perceptions of science among boys and girls haven't significantly changed since the 1980s(Jones et al. 2000).

Role of Textbooks:

- Textbooks play a key role in shaping students' understanding of science and reinforcing gender roles(Lu and Lin 2014; Xiong et al. 2017).
- Studies show gender biases in textbooks can affect female students' interest and performance in science(Mihira et al. 2021).

Background

Textbooks and Gender Socialization:
- Textbooks play a key role in students's gender socialization through their content (UNESCO 2020).
- Encounters with textbook content can shape students' views on gender(Youdell 2006).

Gender Disparity in STEM Education:
- Both the U.S. and China have initiatives to improve STEM education and increase participation(Schleicher 2018).
- Despite reforms and efforts, gender bias and disparities persist in STEM fields(McDermott et al. 2018).

Gender Differences in STEM Participation:
- International assessments show gender gaps in STEM achievement and career aspirations.
- In China, girls underperform in math compared to boys; low interest in STEM careers among both genders (OECD 2019).
- In the U.S., significant gender differences in aspirations for STEM careers, with fewer girls aiming for such careers (OECD 2019).

STEM Curriculum Reforms:
- China focuses on integrated STEM curricula to promote interdisciplinary learning.
- The U.S. aims to increase STEM graduates but faces challenges in female participation, especially in engineering.

Critical literature review

- **Gender Stereotypes in Textbooks:**
  - Increased awareness of gender equality has brought attention to gender stereotypes in textbooks (Košir and Lakshminarayanan 2023).
  - Studies show global disparities in gender representation, affecting students' learning and career choices (Fort and Varney 1989).
- **Global Gender Bias:**
  - Research indicates a persistent gender bias in textbooks, with fewer female characters and stereotypical roles(Guichot-Reina and De la Torre-Sierra 2023).
  - Examples include underrepresentation in STEM fields and traditional gender roles in illustrations(Orfan 2023).
- **Impact on STEM Fields:**
  - Historical male dominance in STEM fields, with efforts to increase female participation.
  - Gender bias persists despite curriculum reforms, affecting female interest and participation in STEM(Jones et al. 2000; Potter and Rosser 1992).

Critical literature review

- **Comprehensive Analysis:**
  - Aiming for a deeper analysis of gender representation in textbooks, beyond numerical imbalances.
  - Focus on subtle reinforcement of gender roles and its impact on students' perceptions.
- **Cultural and Educational Systems Impact:**
  - Investigate how cultural backgrounds and education systems contribute to gender differences in STEM.
  - Address limitations of current research by considering a wider range of sociocultural factors.
- **Implicit Gender Meanings:**
  - Use a social semiotic framework to analyze implicit gender meanings conveyed by images in textbooks.
  - Provide a more nuanced understanding of gender bias and contribute to designing equitable science textbook images.

Research Questions

How can cultural issues such as bias and discrimination be identified through the analysis of gender representations in science textbooks?
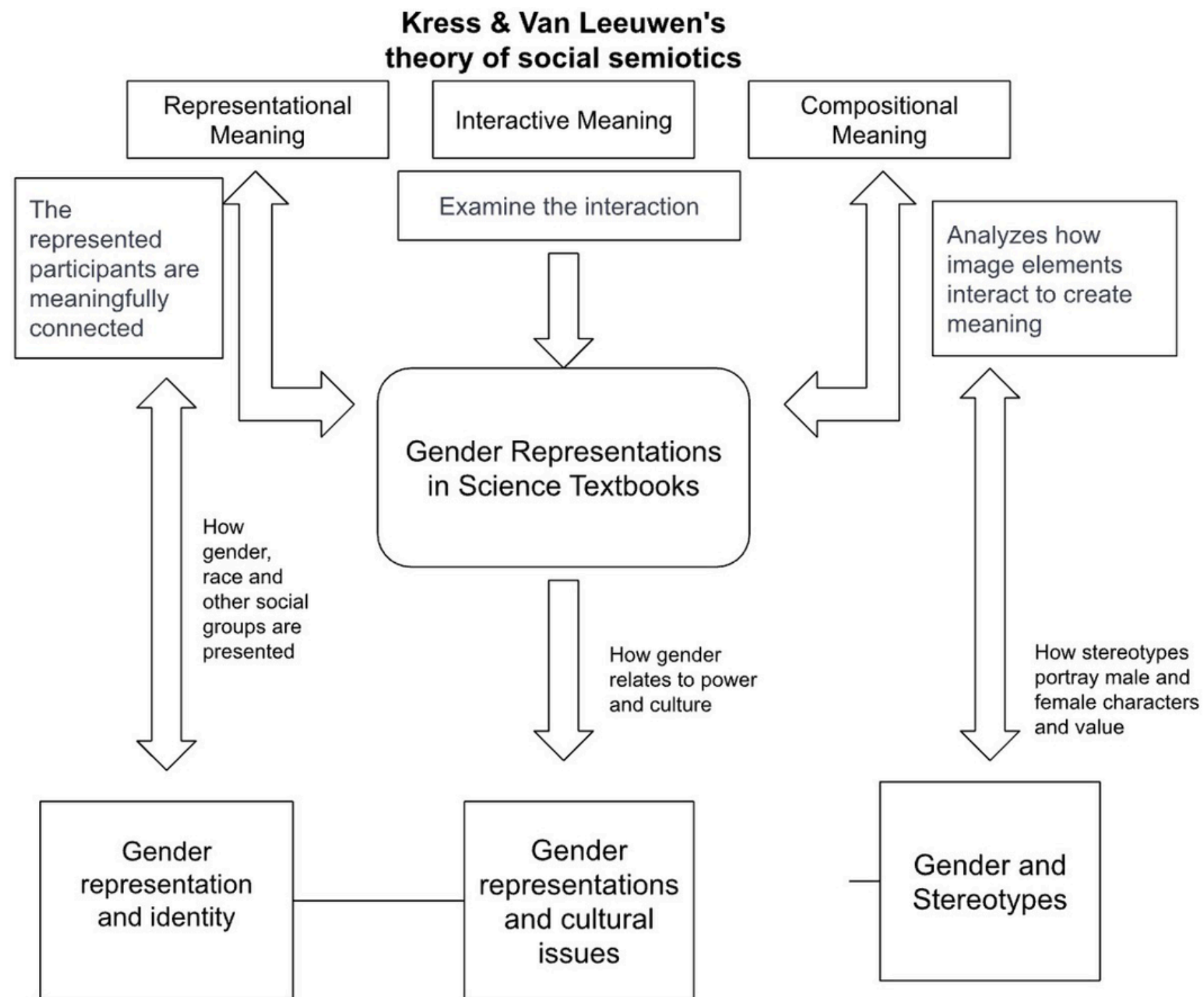
How do gender representations in science textbooks' visual images differ between China and the United States?

what do these differences reveal about each country's cultural narratives?

Conceptual framework

Kress & Van Leeuwen's theory of social semiotics

Representational Meaning

Interactive Meaning

Compositional Meaning

The represented participants are meaningfully connected

Examine the interaction

Analyzes how image elements interact to create meaning

Gender Representations in Science Textbooks

How gender, race and other social groups are presented

How gender relates to power and culture

How stereotypes portray male and female characters and value

Gender representation and identity

Gender representations and cultural issues

Gender and Stereotypes

Figure 1: Gender in Science Textbooks: A US-China Social Semiotics Study

Kress and van Leeuwen's (2006) social semiotic theory, which looks at how images convey cultural values and meanings, including gender roles
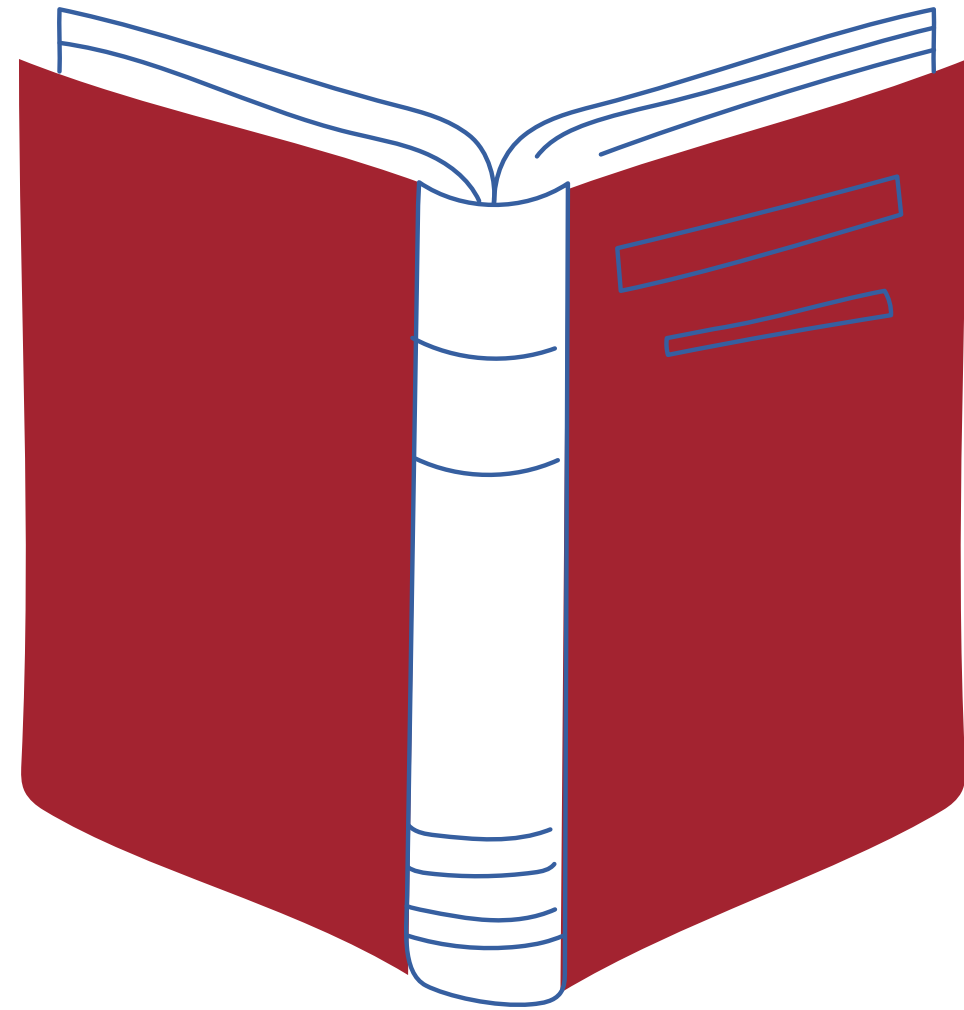
Research
Method & Data

roadmap

1 Textbook Selection and Image Extraction
- 12 textbooks--China, 15 textbooks--US

2 Initial Image Processing
- (Use the pre-trained deep learning model YOLO for feature extraction from the images to identify objects, colors, and shapes, which are crucial for understanding content and potential gender representations.)

**3** Use of LLMs for Image Classification
- coding scheme

4 Manual Coding and Validation

Materials(China textbooks)

- Textbooks Analyzed: **12 textbooks** published by ***Zhejiang Education Publishing House and Shanghai Education Publishing House.***
- Selection Reason: These regions are notable for their focus in PISA surveys and have been pioneers in science curriculum reform, integrating STEM subjects.
- Notable Publishers: *Zhejiang and Shanghai Education Publishing Houses*, with Zhejiang leading in curriculum reform and Shanghai building on Zhejiang's experience.

Materials(US textbooks)
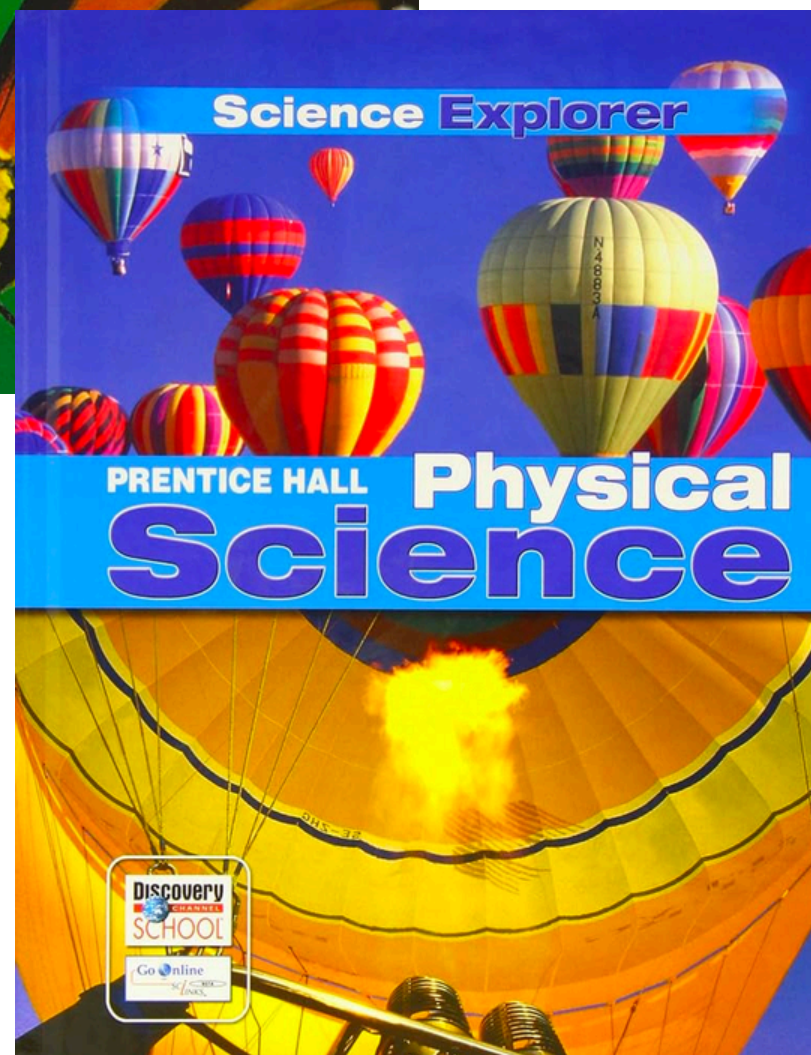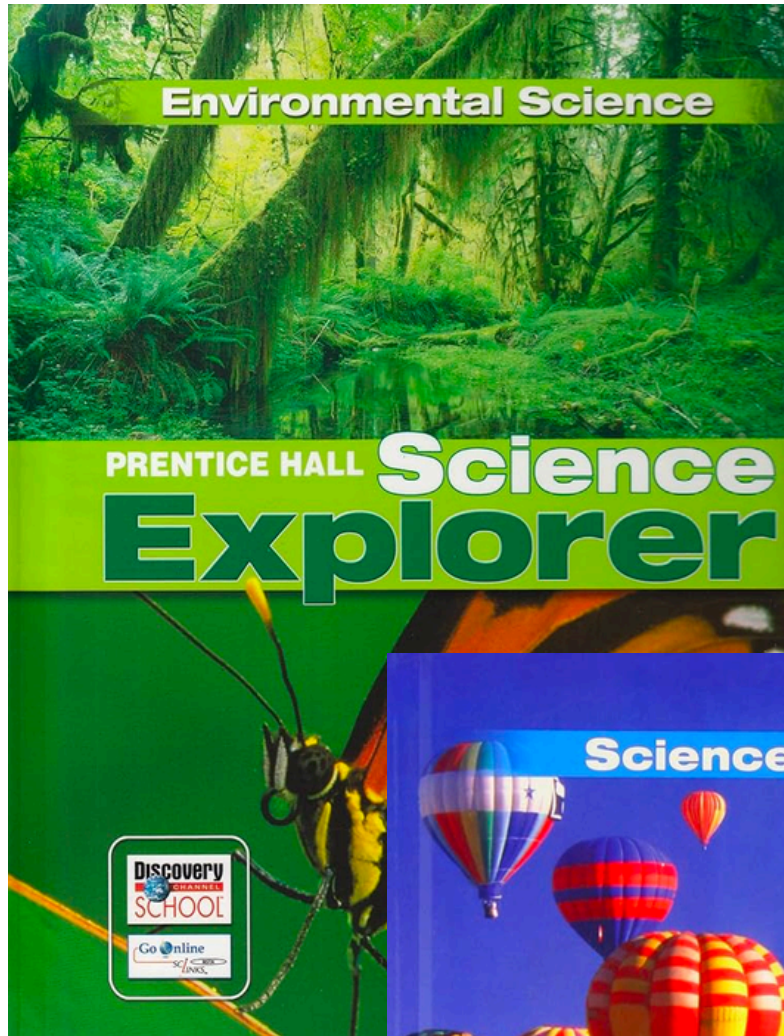
- Textbooks Analyzed: **15 textbooks** published by *Pearson Education Group*.
- Usage: This curriculum is widely used **across all 50 states in 4,200 schools**, indicating a broad and uniform application.
- Introduction to China: **Some of these U.S. textbooks have been introduced by Zhejiang Education Publishing House to China**, aiming to provide advanced materials for implementing new curriculum standards and reforming teaching models.

Coding scheme

- **Objectives:**
  - Focus on explicit and implicit gender representations in textbook images.
  - Include images with identifiable human figures, excluding ambiguous gender representations.
- **Analytical Framework:**
  - Expanded from Solano-Flores (2021) with an emphasis on gender.
  - Explores gender roles through illustration and text analysis, recognizing their combined effect on meaning creation.
- **Key Aspects of the Coding Scheme:**
  - Objects and Backgrounds: Analyzes the style and complexity of visual elements to understand the conveyed themes or information.
  - Diversity and Portrayal: Quantifies the representation of different genders and their occupations to evaluate gender diversity.
  - Metaphorical Visual Language: Examines how visual elements signify states, conditions, or changes through metaphorical representations.
  - Role of Text in Illustrations: Focuses on text that supports visual information, paying particular attention to gender-related terms (e.g., "mother", "father") and their frequency.

Coding scheme

Dimensions		Definitions
Gender representation in illustrations	Obejects and backgrounds	The style and complexity with which objects (components of an illustration on which the viewer's attention is supposed to focus) and background (visual elements that provide context) are represented in an illustration.
	Diversity and portrayal	This aims to count the number of character (including their occupation) of different gender in the numbered illustration.
	Metaphorical visual language	Features that represent states, conditions, or changes in the objects represented in an illustration.
Gender representation in texts	Text in illustration	A form of text intended to support or supplement information provided visually. Include letters, labels, titles, legends, paragraphs, etc. ps: Fouces on name or gender term such as mother, father, son, daughter etc.

Coding scheme

Gaze

demand(When the participants in an image, such as people, look directly at the viewer, it is called "demand gaze") and offer ("Offer gaze" occurs when the participants in the image do not look directly at the viewer but are looking at something else, or their line of sight is not clear.)

demand

offer

Coding scheme

world/global

Social culture focus	family/home; school/class; community/neighrborhood; state/province; home country; world/ global
Gender	women, men, girls, boys
Frequecy	1,2,3...
Occupation	students, scientists, doctors, etc.

Dr. John Carpten

men

1

scientist

Image Data Extraction, Preprocessing, and Classification Approach

- **Use of Large Language Models (LLM):**
  - Applied generative AI technology, specifically LLM, for advanced analysis, including human detection and extracting complex semantic information like gender detection and analyzing human interactions.

- **Two-Stage Method for Accuracy:**
  - Automated Processing with LLM
  - Manual Coding Phase

Expected Findings

1. **Prevalence of Gender Stereotypes:** Anticipate uncovering both overt and subtle gender stereotypes in textbook images, with potential disparities in the depiction of males and females in STEM-related roles and activities.

2. **Cultural Differences in Representation:** Expect to find significant differences in gender representation between Chinese and US textbooks, reflecting broader societal norms and values regarding gender roles in STEM fields.

3. **Influence of Textbook Images on Gender Perception:** The study may reveal how textbook imagery influences students' perceptions of gender roles, potentially shaping their interest and engagement in STEM subjects.