

# Students' Models of the Particulate Nature of Matter: Comparison Between Three Countries

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## Motivation

- Particulate Nature of Matter
    - Significance across science
    - Difficult for students due to abstraction<sup>1</sup>
    - Various aspects<sup>2</sup>
  - Cultural Comparison
    - Theoretical Framework—Constructivism
- Culture { Knowledge before instruction  
Knowledge to be taught

<sup>1</sup>Albanese

<sup>2</sup>de Vos

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## Research Questions

- What are secondary students' mental models of particulate nature of matter in the US, Germany and China?
- What differences, if any exist across students from U.S., Germany and China in terms of their mental models of the particulate nature of matter?

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## Methodology

- Survey—Particle Concept Inventory (PCI)\*
  - 70 statements
  - Four-point Likert Scale + Certainty
- Participants
  - US (n=157, high school seniors, 17 years old)
  - Germany (n=244, middle school, 15 years old)
  - China (n=144, middle school, 15 years old)

\* Silke Melkelskis-Seifert (2002)

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## Analyze Survey Data Using Concept Map

### Goal

- Focus on students' knowledge structure rather than its scientific correctness.
- Use students' responses on the survey to construct a concept map representing students' interconnections between these concepts i.e. their mental model.

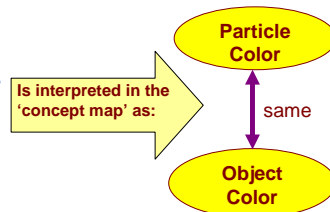
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## Develop Concept Map

Step 1: Identifying the knowledge elements and associations in each statement.

### Statement on PCI

"Particles have the same color as the object in which they are located."



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## Develop Concept Map

- Step 2: Combining various elements and associations
  - Big map
  - Three themes emerged from this map
    - particle existence
    - particle interactions
    - macro-micro property connections
- Step 3: Deciding best fit statement to association

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## Develop Concept Map

Step 4: Calculating strength of association

"True" OR "More true than false"  
AND "Certain" → Association established

Percentage of students believed the link was attributed → Strength of the association

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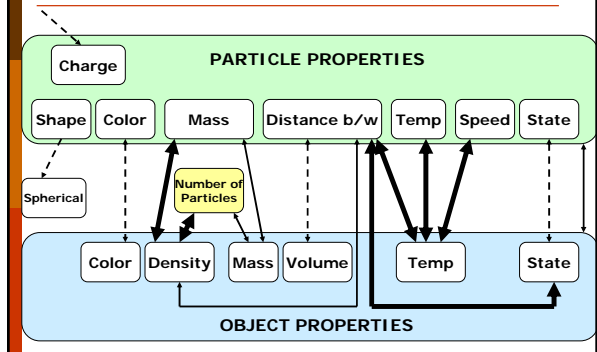
## Develop Concept Map

Step 5: Drawing a collective concept map

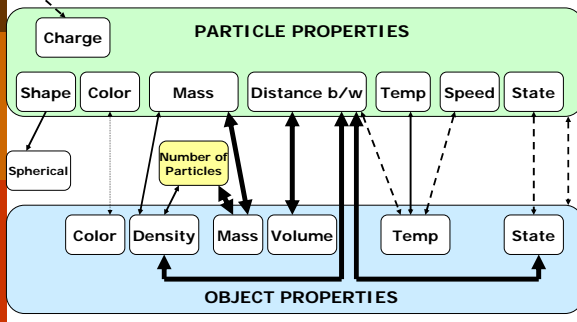
% students to whom link is attributed	Line Style	Association Strength
0-24%	-----	Very Weak
25-49%	-----	Weak
50-74%	=====	Strong
75-100%	=====	Very Strong

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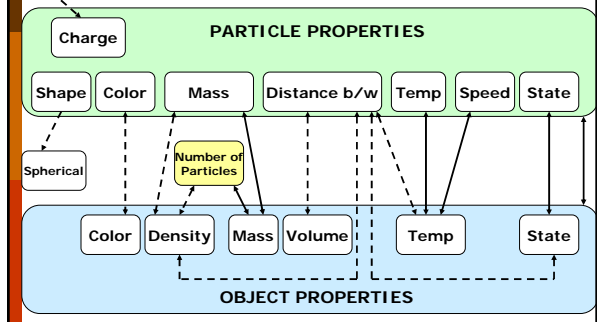
## Results—The US Students' Concept Map Connection Between Particle and Object Properties



## From German Students Connection Between Particle and Object Properties



## From Chinese Students Connection Between Particle and Object Properties



## Summary

### Connection Between Particle and Object Properties

- A smaller percentage of German participants made associations between general particle properties and object properties.
- A larger percentage of US participants made associations between object temperature and particle properties.
- A smaller percentage of Chinese participants made all kinds of associations.
- A larger percentage of German participants believed that particles are spherical.

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## Limitation of Study

- Survey constrained the ways in which we can model student thinking, but allowed us to collect data from a vast population
- Difficult to control the sample representation (students' age, grade, school ranking...)
  - Do NOT intend to use our research results to represent each country as a whole

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**Thank you!**

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