

INVESTIGATING INTRODUCTORY COLLEGE STUDENTS' KNOWLEDGE OF THE PARTICULAR NATURE OF MATTER

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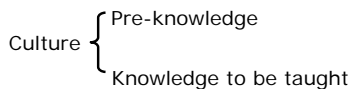
Abstract

This study is part of a larger cross-cultural investigation of students' knowledge of the structure of matter in three different countries. In this study we administered a questionnaire that was developed in Germany to introductory college students in the U.S. The questionnaire includes a Likert scale and open-ended questions focusing on the particulate nature of matter. We interviewed students to probe their understanding of these concepts and to validate the survey questions. In the larger cross-cultural study we will compare our results with those from Germany and China.

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Motivation

- Particle Structure of Matter
 - Significance across science
 - Difficulty for students due to abstract
- Cultural Comparison
 - Theoretical Framework—Constructivism



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Research Questions

- What is the nature of students' knowledge of the particle structure of matter?
- Are there any differences across cultures in the students' knowledge of the particle structure of matter?
- How might culture influence the knowledge of the particle structure of matter?

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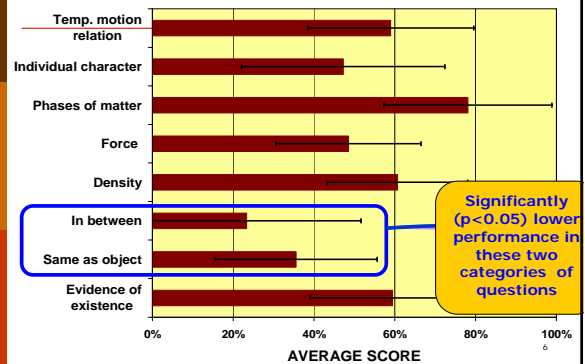
Preliminary Study In the U.S.

- Survey
 - Berlin Particle Concept Inventory (BPCI)*
 - 70 statement: Four-point Likert Scale (major part)
 - Eight categories (Inter-rater reliability = 80%)
- Participants
 - 6 experts
 - 41 college students
 - Non-calculus based summer physics courses at K-State
 - Non-physics majors
- "Correct" ⇒ Agreed with majority of experts.

* Silke Melkelskis-Seifert (2002)

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Survey Results (by category)



Post-Survey Interview (n=6)

(Slide 1 of 2)

Students showed most disagreement with experts on statements students rated hardest/most confusing.

Examples:

- "Particles have the same temperature as the object to which they belong."
- "Air is between the particles of any gas."
- "Particles are a human invention, which only helps scientists interpret certain events that occur in nature."

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Post-Survey Interview (n=6) (Slide 2 of 2)

Example of Student Reasoning

- A particle has an attractive force even if no other particle is around for it to attract. [93% disagree w/ experts]
 - "particle is just charge, so it must have force"
 - "[Particle] has mass, .. some .. gravitational attraction."
- Air is between the particles of any gas. [77% disagree w/ experts]
 - "...has to be something between those particles...,should be air because air is everywhere"
- Scientists' idea of a particle reflects the way things really are. [70% disagree w/ experts]
 - "history of science ...scientists are not always correct"
 - "there is something you do not know and you will never know"

Typical student's mental model

Matter is made up of spherically shaped, ball-like particles. There is always something in between these particles such as air or something else. Particles have a certain charge and mass and also possess attractive forces between each other. The particles of an object are always in motion regardless of the state (solid, liquid or gas) of the object; however, particles never touch each other. Particles have the same property as the object they form. Friction makes particle warm and slows down the motion of particles.

Analogous to what we see in the everyday world!

Conclusion

- Students' lack of knowledge is not uniform across various categories.
- Students found it more difficult to conceptualize abstract situations concerning particles and they relied mainly on their everyday experience.
- In some unfamiliar situations, a few of the students tended to rely on philosophy to explain their answers.

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Future Work

- Compare the data from the US, Germany and China
 - Survey
 - Interview
 - Students
 - Teachers
- Comparison might highlight the *cultural factors* affecting student knowledge

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Implications of Broader Study

- Generalize the research result from one culture/country to another
- Teaching material adaptation and development

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