

Bridging the gap between Research in Science Education and Student Learning

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Outline

- Standards of science education
- The meaning of learning
- Aspects which influence student learning
 - Student characteristics
 - Types of curricula
- Components of science education
- An example of a project based on research in science education
- SciCar
- References

New Standards in Science Education

- The Content of Science that Every Student Should Learn
- The Pedagogy of Teaching Science
- The Assessment of Students
- Professional Development of Teachers
- Organization of Learning

National Research Council (2013)



Learning

- *The most conspicuous psychological influence on curriculum thinking in science since 1980 has been the **constructivist view of learning** (Fensham, 1992, p. 801)*
- *The students need to learn to cope with their life individually within the society in which they live and operate and also to participate actively in **societal discourse concerning socio-scientific issues (SSI)** (Roth & Lee 2004).*

Stuckey, M., Heering, P., Mamlok-Naaman, R., Hofstein, A., & Eilks, I. (2015). The philosophical works of **Ludwik Fleck** and their potential meaning for teaching and learning science. *Science & Education*, 24(3), 281-298.

What influences student learning?

Pre-service, in-service, culture, self-efficacy, ownership, identity, PCK, CPD...

Teachers

Observation

Questionnaires

Class video-taping

Interviews

Teacher reflections

Outcomes evaluation

Student reflections

Students

Curriculum

Cognitive and affective skills, motivation, interest, learning difficulties, misconceptions...

Relevance, Inquiry-based, contemporary, context-based...

Students



- Cognitive and affective skills
- Motivation vs. **learning difficulties**
- Misconceptions and alternative conceptions
- Assessment methods
- Language
- Learning environment
- Cultural background

.....

Language



Cultural diversity

Ruschenpohler, L., & Marcik, S. (2020). Secondary School Students' Chemistry **Self-Concepts: Gender, Culture, and the Impact on Learning Behaviour**. *CERP*, 21, 209-219

Science Language

H_2O

HIJKLMNO

$HCHO$ (CH_2O) – Formaldehyde

Sea Water



Curriculum



- Is it **relevant** to students' lives?
- Is it up-dated according to **scientific and technological** discoveries?
- Is it up-dated according to **societal and economic** changes?
- Does it enhance **scientific and technological literacy**?
- Does it increase students' **interest and motivation** to study science?
- Does it enhance students' interest in **scientific careers?** (Addressing Attractiveness of Science Career Awareness - **SciCar**)

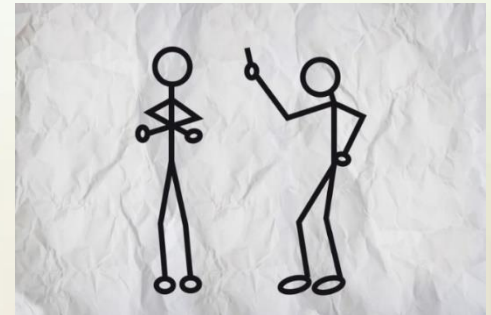
How?

- Inquiry-type approach (asking questions, hypothesizing, drawing conclusions...)?
- Argumentation (focusing on discourse)?
- Context-based?
- Design-based?
- Socio-scientific issues based?
- Using a contemporary research-based, a historical approach, or both?
- Meeting scientists

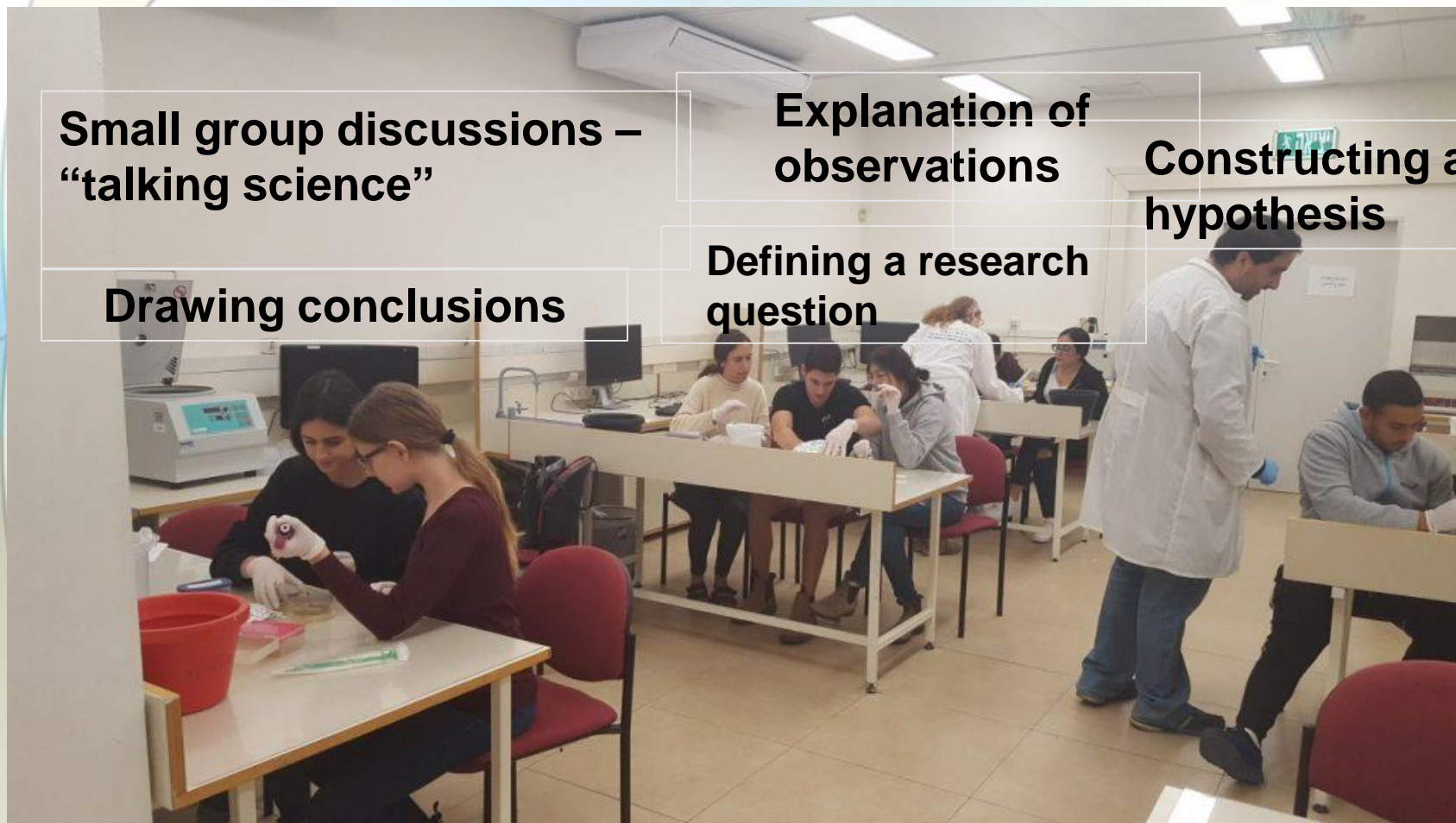


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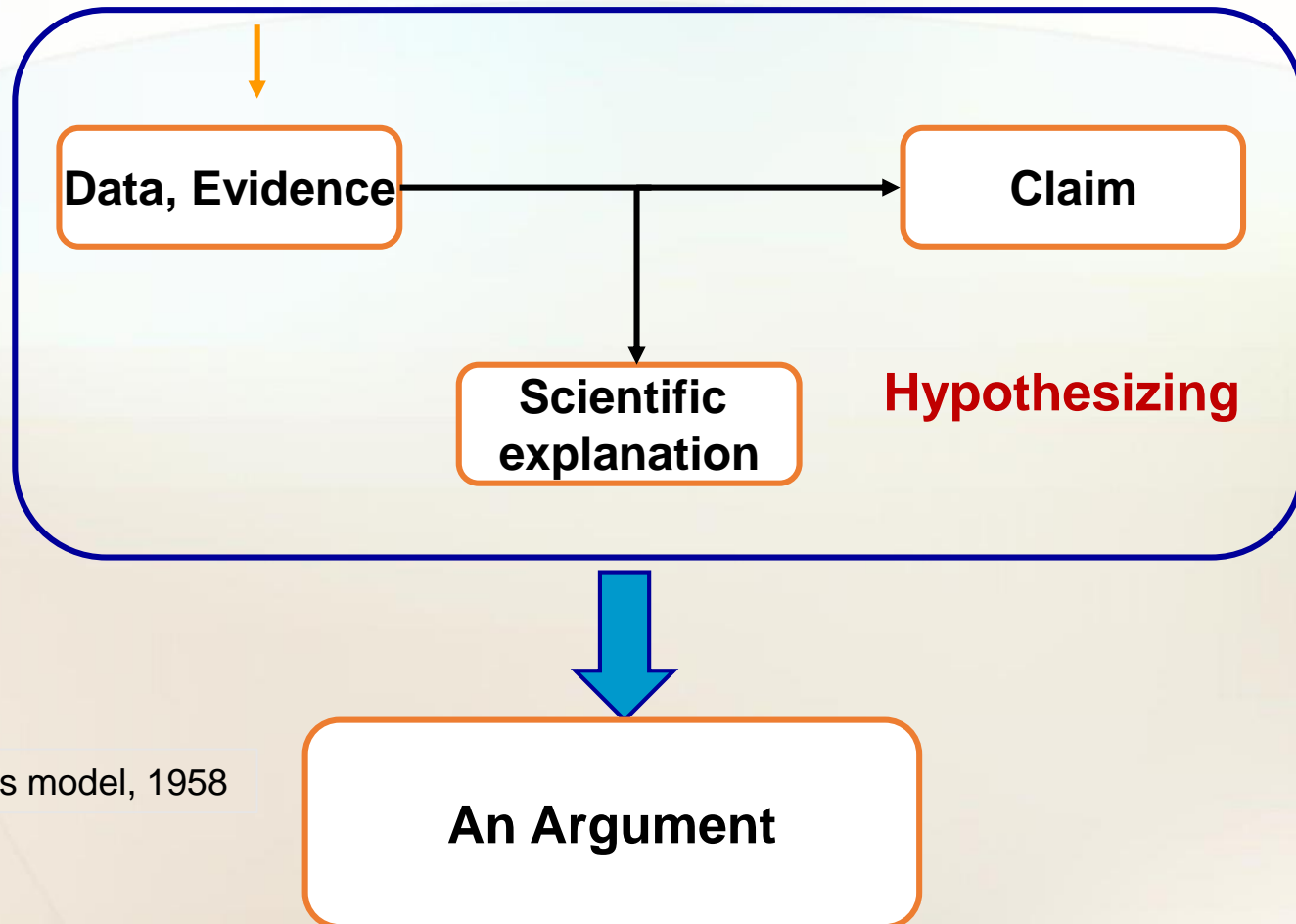
Students Conducting the Inquiry-Type Experiments



Hofstein, A., Dkeidek, A., Katchevitch, A., Levy Nahum, A., Kipnis, M., Navon, O., Shore, R., Taitelbaum, D., & Mamlok-Naaman, R. (2019). Research on and Development of **Inquiry-type** Chemistry Laboratories in Israel. *Israel Journal of Chemistry*, 59, 1-11. DOI: 10.1002/ijch.201800056

Students Learn the Argument's Components in the Inquiry-type Experiments

Performing the experiment



Based on Toulmin's model, 1958

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Context/design-based, need to know, socio-scientific driving questions

How can I design a cellular phone that is safer to use?

Radiation , Plastics, Sound, Disposal of batteries

- Mamlok-Naaman, R., Fortus, D., Dershimer, R.C., Krajcik, J., & Marx, R.W. (2005). How do I design a **cellular phone** that is safer to use? In: P. Nentwig and D. Waddington (Eds.). *Making it Relevant: Context-based Learning of Science* (215-241). Munster / New York / Munchen / Berlin: Waxmann.
- Krajcik, J., & Mamlok-Naaman, R. (alphabetical **order**). (2006). Using **driving questions** to motivate and sustain student interest in learning science. In: K. Tobin (Ed.). *Teaching and Learning Science: A Handbook* (317-327). Praeger, Westport, Connecticut, London.
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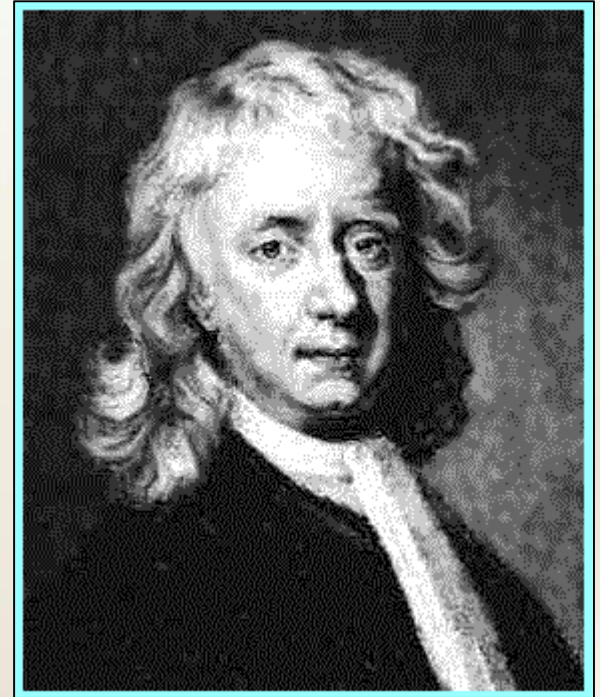
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The role of history in school science programs

To know what something is today we have to learn about what it was like yesterday.

Chinese Daily Newspaper, 2002

Lavoisier



Research findings

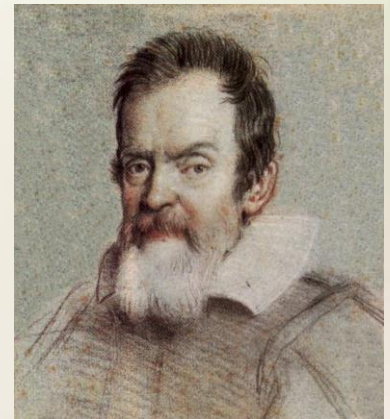
- Students' initial scientific knowledge is analogous to the knowledge of scientists in the ancient world, and it is made up of observations and conclusions that are often intuitive.
- Children believe in what they sense and tend not to believe in what is out of the scope of their senses.

Thagard (1992); Irwin (1997); Erduran (2001); Mamlok-Naaman, et. al. (2005); Erduran, Aduriz-Bravo, & Mamlok-Naaman (2007).

Using history and philosophy in school science programs, in order to promote a better understanding of:

- The nature of science (**NOS**)
- How is science generating evidence?
- How does science contribute to the development of students' skills in communication, evaluation and decision making?
- How do scientists develop their scientific knowledge?

Galileo



SciCar: A 3 days international workshop on climate change in Israel: Research and Education, May 2023

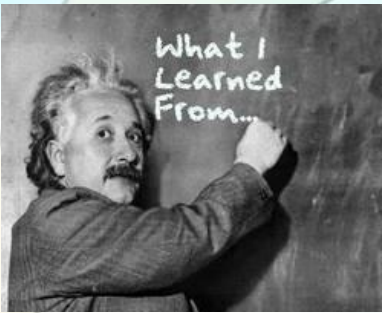
- A visit at a research forest
- A research workshop
- Sustainability Flagship Weizmann
- Climate competencies of the Finnish youth
- Unpacking the connections between climate literacy and sense of place: A case study of an Israeli Bedouin Community in the Negev
- "Speak to Me in Numbers": Teaching SDGs and Developing Skills for Global Citizenship
- Climate Change in the Arctic: Visible & Invisible
- Disaster Psychology - Understanding the Client: People



SciCar: Meeting scientists (job shadows), April 2023



EuroVariety, June 2023,
Tarty Estonia



What have we learned?



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Thank you 😊



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