



Competencies to deal with the complexity of SSI: **Inquiry based methods as the way and as the goal**

*Stein Dankert Kolstø, University of Bergen
Erik Knain, Norwegian University of Life Sciences*



Supported by



Our claims

- ▶ SSI-competencies need to be trained through inquiry-based science education (IBST)
- ▶ **Level of complexity of issue in IBST constrains specificity of learning goals and need for teacher guidance**
- ▶ Different types of IBST for developing single competencies and orchestration of these in complex SSI

Competencies for SSI



- ▶ **Conceptual knowledge:** science, risk and uncertainty, the nature of science, etc.
- ▶ **Methodological and procedural knowledge**
- ▶ **Reading competency**
- ▶ Etc.

Battle of the graphs

Temperature anomaly
Relative to 1900-1990

The IPCC "hockey stick"

Climatic changes in europe
Over the past thousand years

20th-century average temperature

MAD COW DISEASE

Dealing with complexity as a SSI-competency

- **Analyse ill-structured problems**
- **Identify and compare argument from diverse fields**
- **Participate in written and oral debate**

Warm Period

Battle of the graphs

Temperature anomaly
Relative to 1900-1990

The IPCC "hockey stick"

Climatic changes in europe
Over the past thousand years

20th-century average temperature



© www.science aid.co.uk



Transfer

- ▶ Transfer of “school knowledge” to new contexts is demanding
- ▶ More likely if the context of learning have similarities with contexts of application (Anderson, Simon & Reder 1996, Layton 1991)
- ▶ **SSI-congruence needed**





IBSE versus SSI

- ▶ Processes and competencies involved in SSI overlap significantly IBSE (McVaugh, 2010)
 - If we include second hand data and claims in IBSE
- ▶ **SSI and IBSE similarities:**
 - Develop a willingness to ask questions, seek evidence, question and modify ideas, use evidence in argumentation, communicate results for different purposes and audiences







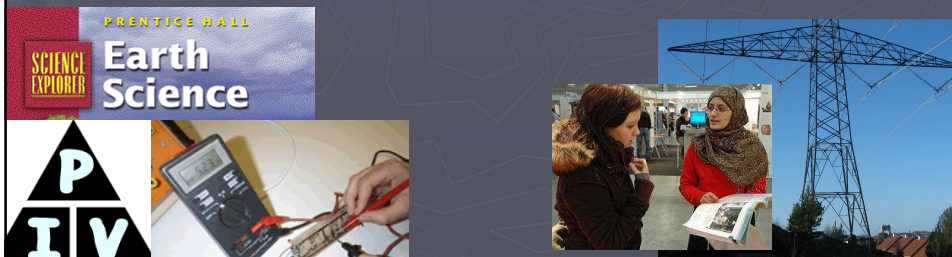
SSI-competency as orchestration?

- ▶ Sub-competencies orchestrated according to the demands of the situation?
 - Analyse ill-structured problems, identify and compare argument from diverse fields etc.
- ▶ Sub-competences
 - Conceptual knowledge, procedural knowledge, learning- and reading strategies etc.



Dilemma teaching SSI by IBST: **Top-down or bottom-up?**

- ▶ **top down approach:** teach all competencies in relevant contexts – overloaded by complexity?
- ▶ **bottom up approach:** teach one at a time – problems of transfer and orchestration?
- ▶ **Our solution:** Use varying types of IBSE with varying levels of complexity and SSI-congruence



Main claim:

**Level of complexity of issue in IBST
constrains specificity of learning goals
and need for teacher guidance**

- ▶ **Specific concepts as learning objectives**
 - Teacher must ensure focus on those concepts
 - Select context minimising disturbing variables
- ▶ **SSI-inquiry as learning objective**
 - Complex issues
 - Teacher must allow for the inquiry to lead to different arguments, concept, etc for different student-groups
- ▶ **Issues with different levels of complexity involves and develops different process competencies.**

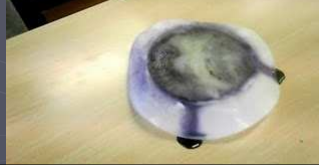
IBSE as closed inquiry

► "The explanation-project"

- Closed inquiry for a specific concept:
- Enzyme (amylase) in saliva breaks down starch

► What happened to the potato when we eat it?

- (Short explanation)
- Hands-on "experiment"
- Discuss and write down the groups observations and explanation
- Class discussion on observations and explanations



IBSE as Open inquiry

► "The wiki-project"

- Topic: Sustainable development – locally
- Student identify problems
- E.g. "Hunting just for fun?"

► Characteristics

- Implies student experience with complexity
- Students in different projects finds different information and arguments – and values
- -> diverging students experiences learning outcome



Complexity of IBSE-issue versus learning outcome – and teaching method

Complexity of issue	Typical issues dealt with	Specificity of teacher structuring	Specificity of learning outcome
Low	Scientific concepts	Teacher-guided	Correct explanations
Intermediate low	Scientific laws	Structured inquiry (half-open)	Well-known empirical relations
Intermediate high	Technological quality	Partly structured (Open testing)	Loosely defined learning outcomes
High	SSI	Scaffolding (Open inquiry)	Personal judgements

Consequences for SSI-teaching

- ▶ Different types of IBST might develop
 - single competencies
 - orchestration of these in complex SSI.
- ▶ All variations in complexity needed!
- ▶ IBST might develop competencies in contexts with high SSI-congruency

