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Scaffolding Scientific Argumentation Between Multiple Students In Online Learning Environments To Support The Development Of 21st Century Skills

why scientific
argumentation?

ž inquiry and argumentation are at the heart of current efforts to help students develop scientific literacy (AAAS, 1993; NRC, 2000)

ž scientific literacy involves understanding:

- how knowledge is generated, justified, and evaluated by scientists
- how to use such knowledge to engage in inquiry in ways that reflect the practices of the scientific community

ž scientific argumentation is ultimately about:

- developing, warranting, and communicating a persuasive argument in terms of the processes and criteria valued in science
- constructing, critiquing, and communicating sound and valid arguments in terms of the connections between and among the evidence and theoretical ideas

ž these are central 21st century skills

students face challenges

- ž making sense of the phenomenon (e.g., Abell, Anderson, & Chezem, 2000; Kuhn & Reiser, 2005)
- ž generating a sufficient and useful explanation (e.g., Ohlsson, 1992; Sandoval, 2003)
- ž justifying their explanation using appropriate evidence and reasoning (e.g., Bell & Linn, 2000; McNeill & Krajcik, in press)
- ž evaluating the validity or acceptability of an explanation (e.g., Hogan & Maglienti, 2001; Clark & Sampson, 2006)

- ž unfortunately, opportunities for students to engage in scientific argumentation in the classroom are typically rare (Newton, Driver, & Osborne, 1999; Simon, Erduran, & Osborne, 2006)

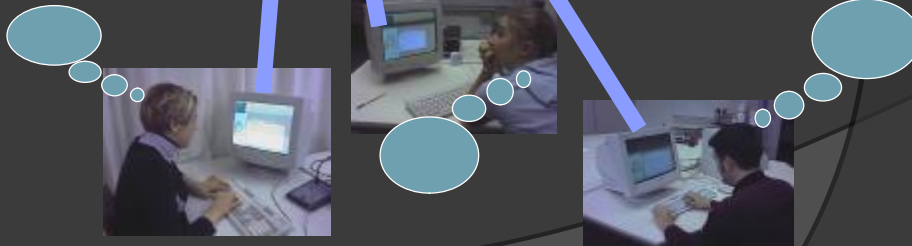
- ž research over the past 15 years has focused on computer-enhanced environments to support students constructing arguments and engaging with one another in argumentation
- ž these environments can also support students' development of 21st century skills

adaptability

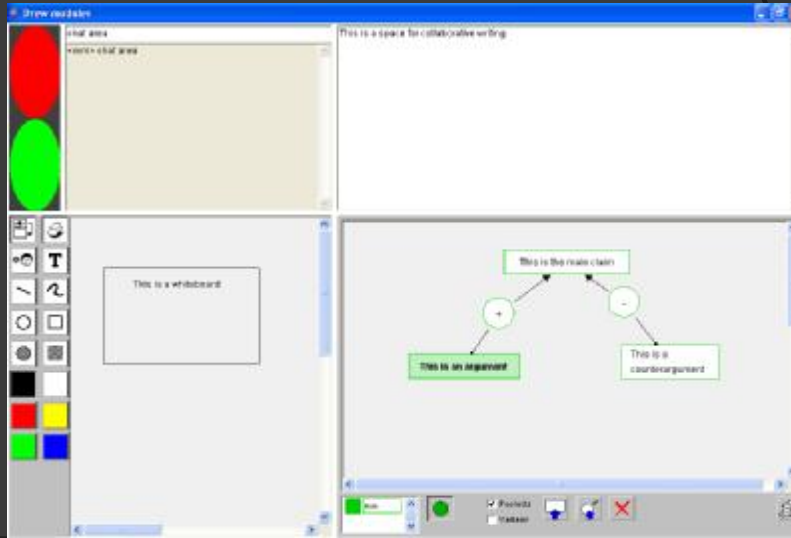
- ž students adapt their everyday communication skills to align more closely with the values, habits of mind, and criteria involved in scientific argumentation
- ž students adapt to new technologies
- ž argumentation skills can be viewed as central to helping individuals adapt to changing circumstances in their environment

CASSIS discussion

8	Lernz. nr. problemorientiert gestalteten Design	New	Kassian	2001
9	1. Versuch	New	Calsenna	2001-03-10 10:38:00
9	2. Versuch	New	Suzanna	2001-05-01 20:15:43+01
9	Endfassung	New	Calsenna	2001-02-14 21:12:40
9	Konk.	New	Carola	2001-02-01 08:29:00
9	Konk.	New	Isabella	2001-01-27 14:42:00
9	So, ein weiterer Versuch...	New	Suzanna	2001-02-03 12:47:34+01
9	Übersicht *Case	New	Calsenna	2001-02-04 19:39:34+01



DREW environment



complex communication
skills

- ž many environments focus on helping students learn how to work toward consensus
- ž students need to communicate complex ideas in order to build a shared understanding
- ž scientific argumentation is ultimately about developing, warranting, and finally communicating a persuasive argument
- ž scripts integrated into the environments support students in these roles

CASSIS single-argument script

Case class reunion

At the class reunion a former classmate, who is now studying physics and is tutoring other students to finance his studies, says, "I read in the news paper some time ago, that girls are worse in maths and physics although they're not less talented than boys. Almost everything is environmental, almost nothing genetic. Those girls seem to somehow think different about their abilities than boys. I can't recall it exactly. However, their parents and teachers encourage them to think that way by giving them awkward comments. That article said something about some kind of training that the girls were put through. And even so the teachers. Because of that I always give the girls exercises that are simpler so they can experience success and I am able to command them."

Claim
Girls usually are attributing internally stable.

Grounds
As said in the problem case, girls think differently about their abilities than boys.

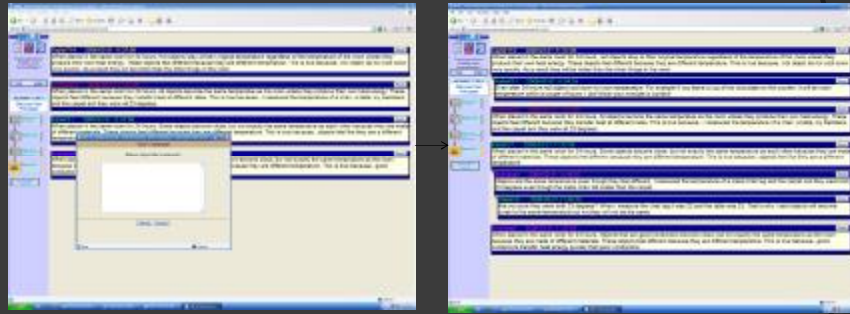
Qualifications
However, the tutor isn't very sure about the details of the newspaper article he read.

TARA: My analysis

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#1 girls.
Here are my arguments:
1.
CLAIMs
Teachers affect the motivation of girls negatively.
Grounds
They give awkward comments, i.e. they enhance the internally stable
Attribution by women rather as reason for failure.
Qualifications
The problem case is somewhat unclear with respect of what teachers
or parents say regarding the mentioned newspaper article.
  
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WISE conflict schema



non-routine problem solving

- z environments promote non-routine problem-solving skills by providing access to rich sources of data and tools to investigate complex questions
- z this involves pattern recognition, deduction, analogical thinking, and several other key problem-solving skills in a context that is constantly shifting as students interact with one another and add new ideas to the mix

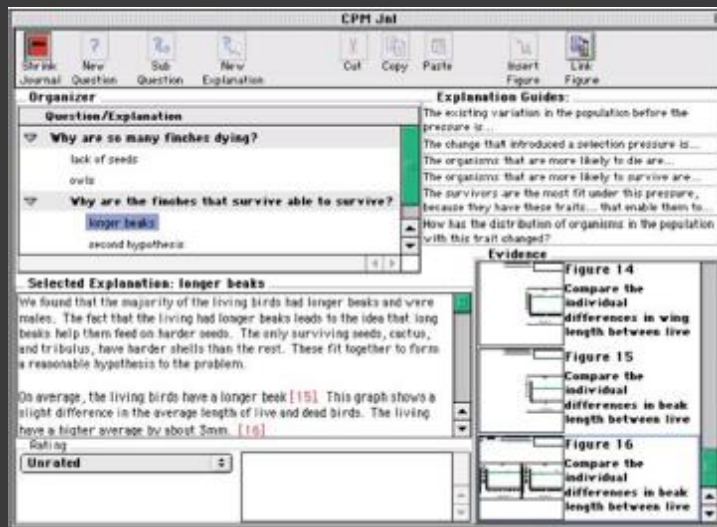
WISE

Design Pattern	Activity
<p>Predict: Introduces students to a scientific phenomenon and elicits predictions.</p>	<p>Activity #1: <i>What do you think?</i> Introduces students to diving question and elicits student's ideas about thermodynamics.</p>
<p>Observe: Allows students to test their alternative ideas and allows them to gather evidence that can be used to distinguish among ideas.</p>	<p>Activity #2: <i>Experiment!</i> Students measure the temperature of objects in the room.</p>
<p>Explain: Learners attempt to reconcile discrepancies between their prediction and their observations.</p>	<p>Activity #3: <i>Heat Transfer at the Atomic Level.</i> Students explore a simulation that shows heat transfer between a hot cup and a warm table at both the macro and micro level.</p>
<p>Critique: Students evaluate the validity of scientific claims.</p>	<p>Activity #4: <i>Thermal Conductivity.</i> Introduces students to differences between thermal insulators and conductors.</p>
	<p>Activity #5: <i>Conductivity, Temperature Change, and Feeling?</i> Introduces students to differences between insulators and conductors in terms of how they feel and the rate in which they heat up or cool down.</p>
	<p>Activity #6: <i>Create Your Principles for the Debate.</i> Students develop principles to explain everyday phenomena.</p>
	<p>Activity #7: <i>Discuss your Principles.</i> Students critique the principles of other students in Personally-Seeded Discussions.</p>
<p>Personally Seeded Discussions can be used as a way to organize an inquiry-based physics curriculum.</p>	<p>Software can be used to support students as they develop principles.</p>
	<p>Students can use technology to gather data about thermal phenomena.</p>

WISE Principle Maker



BGuILE ExplanationConstructor



self-monitoring and self-development

- ž participant awareness tools help students monitor their own participation or contributions and the participation or contributions of others
- ž another approach to supporting self-management and self-development involves metacognitive prompts

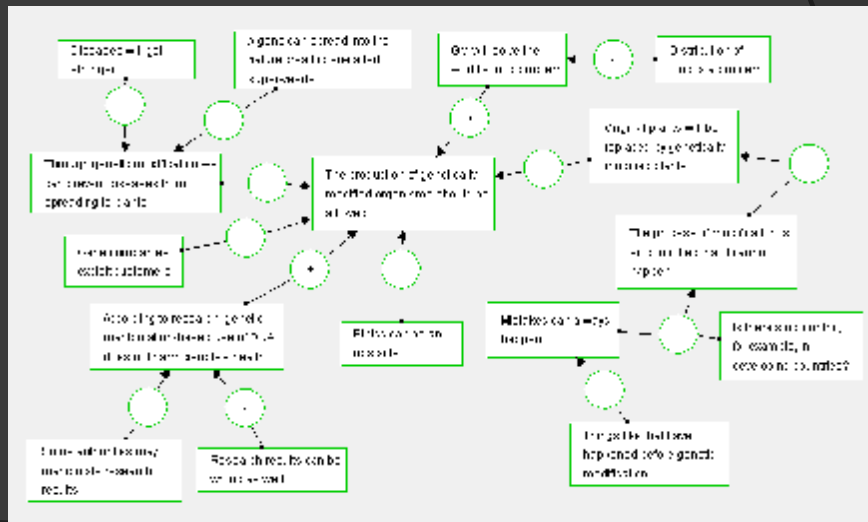
CASSIS argument sequence script



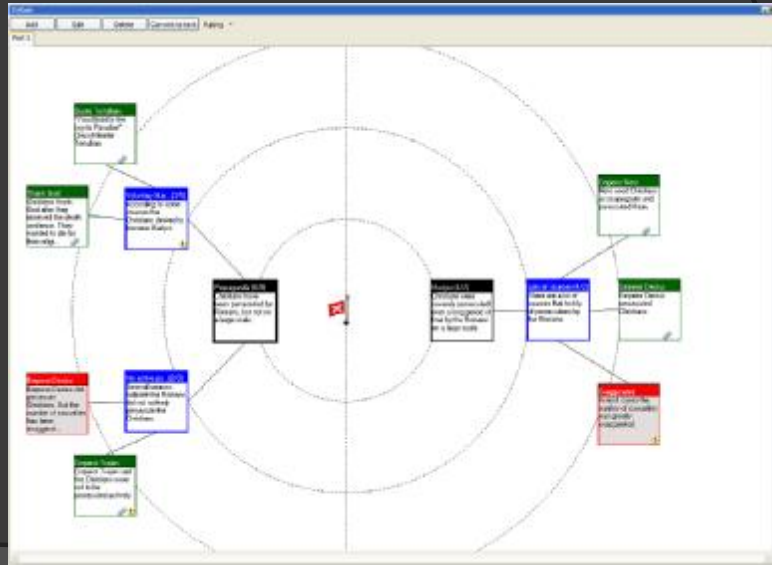
systems thinking

- arguments are systems of claims, warrants, backings, and data that can involve substantial complexity as they evolve through discussion
- students must examine how the components of an argument or counterargument fit together
- students can be scaffolded in specific roles as they investigate complex systems

DREW diagramming tool



VCRI debate tool



research and assessment

- ž quasi-experimental or experimental designs
- ž most current research focuses on specific activity structures and scripts

- ž different evaluation approaches due to differences in focus (e.g., Clark, Sampson, Weinberger, & Erkens, 2007; Erduran, 2008; Sampson & Clark, 2008)
- ž assessments focus on skills related to 21st century skills:
 - argumentative interaction
 - learning of argumentation skills
 - content learning

relationship to literature

- ž environments integrate design principles developed through research on argumentation and the learning sciences (e.g., Bransford, Brown, and Cocking, 2000)
- ž environments focus on skills, habits of mind, and communication processes central to science and 21st century skills

*domain-specific aspects of
science and 21st century skills*

- ž there are certainly domain-specific aspects of argumentation in science
- ž environments focus on forms of argumentation that generalize to certain other domains
- ž this generality supports 21st century skills (and partaking in societal debates and political life within democratic societies)

ž national science standards, however, place heavy emphasis on inquiry and argumentation and thus provide excellent opportunities for integration of these skills into the curriculum

generalizability of research to other science ed curricula and environments

- ž many environments organized as “scripts” that orchestrate and structure students’ interactions with each other and the environments
- ž most research focuses on the efficacy of clearly defined scripts, tools, and activity structures
- ž research thus supports incorporation into other online and offline curricula and learning environments

Thank you!

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