Knowledge Community and Inquiry - Scaffolding individual, Collaborative and Collective Inquiry

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Thanks to

Vanessa Peters, Cheryl Madeira, Mike Tissenbaum, Michelle Lui, Cresencia Fong, Rebecca Cober, Alisa Acosta (*Researchers: University of Toronto*)

Armin Krauss, Colin McCann, Matt Zukowski, Gabby Resch, Antonio Gamba, Rafael Pascual Leone, Michael Moncada (Developers: University of Toronto)

> Tom Moher, Alessandro Gnoli, Brenda Silva (Researchers: University of Illinois at Chicago)

Ben Peebles, Julia Murraye, Richard Messina, Maria Nino Soto (*Teachers: ICS & UTS Schools*)



Personal History and Context

Slotta - research

Cognitive Psychology - Pittsburgh 1990 - 1996 Web-based Learning Environments - Berkeley 1997 - 2005

Collective Inquiry for Secondary Science - Toronto 2006 - present

Smart Classrooms, Orchestration - Toronto 2010 - present

Web-based Inquiry Science Environment - Scaffolding students and teachers



Help Students Learn From Each Other - Discussion, debate, peer review



Contributions of WISE

- Enabled research of pedagogical patterns:
 - Design, debate, critique, modeling, others
- Scaffolds students and teachers new classroom patterns
- Supported 20-30 researchers, internationally
- Pioneered author-ware, portal technologies
- Created "Open" curriculum library
 - Disciplinary partnerships (Wolves, Frogs, Aquarium, Physiology)
- Research partnerships
 - U.S., Canada, Europe, Scandinavia, Asia

The "Knowledge Community" Approach





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The Knowledge Community Approach

- Students work collectively to aggregate and edit a corpus of materials (e.g., wikis, notes)
- Students drive learning, define questions and methods
- Emphasis on community identity and growth (instead of individual learning)
- Focus on discourse patterns, distributed expertise
- Used within several lines of educational research
 - Scardamalia & Bereiter (Knowledge Building)
 - Hakkarainen & colleagues (Progressive Inquiry)
 - Brown & Campione & colleagues (Fostering Community of Learners)

Challenges to the Knowledge Community Approach (for researchers and teachers)

- Addressing specific learning goals and standards
 - E.g., chemistry, Biology
- Complex interactions, inquiry processes
 - Group membership, roles, materials, exchange, technologies...
 - guiding the "flow" or sequence of activities
- Managing and using the classroom knowledge base
- Supporting student meta-knowledge
 - Epistemological perspective (also the <u>teacher's!)</u>
 - Role of community, knowledge, peers, etc
- Assessing student progress; Giving feedback

Research turning point (2006)

- Began very modestly, wanting to consider classrooms or multi-classrooms as "Web 2.0 communities"
- Began to re-learn about FCL and Knowledge Building
- Tension 1: individual learning < -- > collective knowledge building
- Tension 2: unfettered inquiry < -- > progress on defined learning goals
- Identified secondary science as a key requirement
- Inspired by FCL, sought to develop a pedagogical model that could connect students as a community but ensure individual learning progressions *and* some open inquiry. 11

Phase 1 Discussion

Questions

- If you were a high school biology or physics teacher, what would be the biggest challenges to supporting your students in defining their own inquiry questions and approaches?
- How hard do you think it would be to "unseat" students' epistemic commitment to individual achievement (grades, exam performance)? Are they natively interested in collective knowledge advancement? Have they developed some sense of collective epistemology, as a result of possible engagements in Web 2.0 communities?



Knowledge Community and Inquiry

Pedagogical Model for Collective Inquiry

- Establish a knowledge community
 - focus on "collective progress" (social epistemology)
- Include Student Contributed materials
 - Student ideas become resources for curriculum
- Complex, Collaborative interaction designs
 - Multi-week (i.e., whole semester) curricula.
 - Small groups, cooperative tasks, interdependence of groups
 - Building a "knowledge base" and then applying it.
- Social aggregation of content (e.g., "Web 2.0")
 - Wiki, Semantic metadata, social networks
 - Students ' inquiry depends on ideas from peers

Pedagogical Model - definition

- Instantiate theoretical principles about learning
- Structural, functional and relational assertions
 - Domain General (can apply to many topics)
 - Commitments to: Content domain + learning processes + epistemic cognition.
- Produces testable, high-level curricular "scripts"
 - Individual, collaborative and collective activity sequences
 - Roles, goals, responsibilities
 - Pedagogical Logic
 - Switching conditions, grouping/re-grouping conditions

Knowledge Community and Inquiry (KCI)



KCI Elements

- Epistemological commitments
 - "We're all in this together; its <u>how</u> we're going to learn"
- Collective construction of Knowledge Base
 - <u>Student contributed pages, notes, images, votes, tags, etc.</u>
- Collaborative Inquiry projects
 - Use the knowledge base as a resource, index to science domain
- Assessable Learning outcomes
 - Link directly to learning goals (standards)
- Sustained, distributed interactions
 - Multi week, often semester long curricula

KCI Principles

Principle 1: Students work collectively, creating a knowledge base that serves as a resource for their inquiry within a specific science domain.

Epistemological Commitments

- Students "identify" as a community: goals and purposes of learning together and advancing the community's knowledge.
- The knowledge base needs to be understood and valued as "their community resource."

Pedagogical Affordances

- Knowledge base: indexed to the targeted science domain
- Activities indexed to semantic and scripting variables

Technology Elements

 Wikis, database, tools and materials, tablets, computers & phones, metadata schemes, tagging schemes

P-E-T Triangle: design tensions



KCI Design Tensions

• Declares a value (Chinn, 2012) for the quality of learning



KCI Principles

Principle 2: The knowledge base is accessible as a resource, as well as for editing and improvement by all members.

Epistemological Commitments

 Knowledge building processes: improvable ideas, measurable or observable progress within the knowledge base, emergent content organization (i.e. semantic structure)

Pedagogical Affordances

- Scripts for jigsaw and collaborative knowledge construction;
- visualizations and interfaces for accessing the knowledge base;

Technology Elements

- Socially editable media, wikis, notes, or collections of observations; social tagging; visualizations; recommender agents
- Authorship attributions; versioning and forking

KCI Principles

Principle 3: Collaborative inquiry activities designed to address the targeted science learning goals, including assessable outcomes .

Epistemological Commitments

- Inquiry: students build on existing ideas to develop understanding.
- Social/Collaborative dimension of shared ideas, discourse and practice

Pedagogical Affordances

- Critique, comparison, design and reflection.
- Students create artifacts, reflect on those artifacts, and apply them as resources within a larger inquiry project.

Technology Elements

 Web-based learning activities, wikis, Web portal, video editing, simulations, tablet-based observation forms, laptop and tablet interfaces

Individual Students: - Inquiry Trajectories in KCI



Scaffolded Inquiry

- Individual learning activities
- Promote interactions
 - With peers
 - With materials
 - With physical and virtual environments

KCI Principles

Principle 4: The teacher's role must be clearly specified within the inquiry script, in addition to a general orchestrational responsibility.

Epistemological Commitments

- Teacher must see student learning as a collective endeavor (not just "group learning") and see herself as a member of that community
- Teacher must understand student-generated knowledge as a paramount product, raw resource, and driver of inquiry

Pedagogical Affordances

- Teacher-led discussions bring community into focus, consensus.
- Teachers facilitate learning by interacting with students
- Technology Elements
 - Smart boards, tablets for teachers. Consequential scripting for teachers; Orchestrational supports (ambient displays, etc)

Research Methods - KCI studies

- "Model-based Design research"
 - Design-based research (Brown, 1992; Collins, Joseph & Bielaczyc, 2004)
 - model-based research (FCL, Collaborative Reasoning, Case-based, LBD, PI)
- Substantial curriculum (several weeks or months)
 - Implement KCI model, integrate technologies
- Co-design process (Roschelle et al., 2007)
 - 3-6 months prior to the start of unit and throughout implementation
 - Teacher "owns" the resulting curriculum
 - Design targets study of research questions

"Scripting" Complex Pedagogical Designs

- External scripts: "instantiate" the pedagogical model
 - E.g., Collaborative argumentation (Kollar, Fischer, & Slotta, 2007)
 - E.g., Concept Grid, (Dillenbourg, 2002)
 - E.g., Collaborative Reasoning (Richard Anderson)
 - E.g., Fostering Communities of Learners (FCL- Brown and Campione)
- Specify the pedagogical flow/logic
 - Roles or groups for students and teacher(s)
 - Materials, activities, assessments (for each group)
 - Transition points or Conditions (changing group or activity)
 - Notion of "unbound" or open ended scripts that depend on emergent phenomena

KCI Climate Change unit - 10 week, coherent curriculum

- Participants
 - 5 class sections (108 students) of a grade 9 science class.
 - Three teachers (2 sections, 2 sections, 1 section)
- Technology environment: Custom Drupal platform

• Overview:

- 1 week of epistemic treatment, defining emergent "issues"
- 6 weeks of collaborative knowledge construction (issue pages)
- 2 weeks of scaffolded inquiry (remediation plans)

Epistemological Framing & Building Community Knowledge

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

Introduction to Knowledge Community

- Collaboration in sciences
- Knowledge Community
 Example of an attempted knowledge community

Initiating Community Knowledge

Create annotated reference pages individually
Share the reference pages in Drupal

Technological Scaffold

•Drupal page for references •Tagging

& Epistemic Elements

Pedagogical



Small Group Collaboration

Pedagogical & Epistemic Elements •Brainstorming issues related to Climate Change

Personal Reflection
Philosophy of science
Attitudes toward collaborative work

Technological Scaffold

Personal reflection form













Search this site:

(Search)

Hedieh

- My account
- My Reflections
- References
- Brainstorm
- Issues
- Images List
- Remediations
- My Group
- Log out

Useful Links

- Helpful Hints (Open in a new window)
- References List (Open in a new window)
- Editing Tips (Open in a new window)

Links for teachers

Home

Add an issue

| Title | Description |
|---|--|
| Agriculture/Traditional | Increase of droughts and crop failures |
| Alberta Tar Sands | $^{\circ}~$ do you know just how bad these are??? |
| Carbon Tax, carbon credit, carbon offset programs | Carbon tax (focus of alt. section in |
| Changing Migration Patterns | Disturbance in migration routes |
| Deforestation | ° |
| Desertification | NOTE - some of the below don't fit anymore |
| Economy | Economy/Sustainable Technologies: |
| Fishing Industry | many fish stocks are already stressed |
| Glaciers melting | Melting ice will cause less tourism in |

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Collective Knowledge Construction 1 2 3 4 5 6 7 8 9 10 11 12 14 15 16 17 18 19 20 20 20

Pedagogical & Epistemic Elements

Technological Scaffolds Collaborative inquiry: Issues groups

- Integrate scientific concepts (sections)
- Planning & Monitoring
 - Planning pages for groups
 - Reflection notes
 - Drupal "Issue templates" and tags
 - Planning pages, reflection notes
 - Peer comments
 - Models

ullet

- TELS: Global Warming/Virtual Earth
- Canadian Centre for Climate Modeling





Indexing the Knowledge Base: Drupal page sections

The Sciences

Greenhouse Effect:

Please give a detailed description of how the science of greenhouse effect causes or influences your issue.

Thermal Energy and Circulation:

Please give a detailed description of how the science of thermal energy and circluation causes or influences your issue.

Carbon Sinks and Sources:

Please give a detailed description of how the science of carbon sinks and sources causes or influences your issue.

Evidence:

Here are some sources of evidences that documents this issue.

Models and Scenarios:

Legislation:

Here are some current legislations that have been put in place to address this issue.

Remediation:

Here are some current efforts that have targeted this issue in attempt to slow it down.

Supporting Collaboration: Drupal "planning pages"

Create Todo Page

Please use this page to coordinate your authoring efforts with your peers.

Title: * Show summary in full view Body: : " 🎭 🗲 | 개. 사 🏋 | 🎟 💷

- 🗹 📖 📰

Reflection Notes: Collecting student ideas

Reflection 5
View
Edit
Results
Track

Thu, 11/12/2009 - 17:05 - Anonymous
How do greenhouse gases relate to your issue: *

- Adding content to your issues page.
- Signing up for a section on your group page.
- Completing the section for which you had signed up.
- Editing content added by other group members.
- Leaving comment for group members on the quality of their work.
- Leaving comment for group members pointing out things that need to be done.

How have other members of your group helped you understand this topic of greenhouse gas and how it relates to your issue?: *

How do you feel that you can help your group mates get more involved and be more productive: *

Culminating Inquiry Project 1 2 3 4 6 7 8 9 10 12 13 14 15 19 19 20 21

Pedagogical & Epistemic Elements

• Small Groups

- Within-section groups
- •Remediation plans
- •Linking to relevant issues

Technological Scaffolds

- Drupal template (simultaneous editing)
- •Tags
- •Models
 - •TELS: Global Warming/Virtual Earth
 - •Canadian Centre for Climate Modeling

| Description: | [Edit] |
|--|--------|
| Please describe the Remediation clearly (~2 paragraphs; ~300-500 words). | |
| test - jim | |
| Issues Impacted: | [Edit] |
| Please list all issues that are related to this remediation from the Issues list your classmates have explored. | |
| Effectiveness: | [Edit] |
| Describe how the remediation will be effective for two of the issues in your list above where it appears to have had the greatest impact. (1 paragraph per issue; ~150-250 words each) blibliblib | |
| Overall Effectiveness: | [Edit] |
| Based on the sections above, how would you summarize the overall effectiveness of your remediation? (~ 1 concise paragraph; 250 words) | |
| Improvements/Extensions/new Alternatives to the Remediation: | [Edit] |
| Now, provide suggestions about how to improve the Remediation's effectiveness (~500 words) | |
| | |
| $^{\circ}$ e.g. by extending on the remediation, or recommending legislation (laws) with accompanying penalties/rewards | |
| | |
| Or, perhaps you can see an alternative remediation that could be implemented. | |
| Prediction of Future Effectiveness of Modified Remediation: | [Edit] |
| | |
| Assuming that your remediation was applied faithfully (including monitoring and enforcement) for the next 50 years, what will be the impact climate change, in general and in terms of the specific issues you have discussed above? | on |
| Please justify your response in terms of the science of climate change, and feel free to use the WISE Climate Change models for Greenhouse gas andPopulation/CO2 emissions (by running the model, adjusting the variables, and taking a screen capture of the model in 50 years time. sure that you describe what changes to the model's variables you made, and why.) | Make |
| | _ |

Outcomes: Climate Change Unit

- 46 Climate Change Remediation Projects (collaborative, within section)
 - KCI "Assessable Outcomes" indexed to learning goals
 - Each one addressed at least 3 issues
 - Each one included major components of climate science
 - Each included a segment on modeling
- Students achieved a high competency on science content
- Applied their knowledge in a constructivist inquiry task
- Adopted collaborative and collective epistemic values

Learning Gains - Climate change science

Significant learning gain (p<0.001 t=15.69)</p>



Phase 1 Discussion

Questions

- If you were a high school biology or physics teacher, what would be the biggest challenges to supporting your students in defining their own inquiry questions and approaches?
- How hard do you think it would be to "unseat" students' epistemic commitment to individual achievement (grades, exam performance)? Are they natively interested in collective knowledge advancement? Have they developed some sense of collective epistemology, as a result of possible engagements in Web 2.0 communities?

Phase 2 Discussion

Questions

- Is KCI too scripted to be counted as a "knowledge community approach"?
- Will it still be difficult to learn secondary science this way?
- How would students respond to such instruction?



Technology-Enhanced Scripting and Orchestration

Smart Classrooms

- Orchestrating Collective Inquiry

- Investigate the role of the physical learning space
 - Walls, floor, furniture, physical location of students
- *Embodied forms of learning*; tangible & physical elements
- Core technology: SAIL (open source smart classroom)
 - XMPP messaging; real time data mining; intelligent agents
- New forms of human computer interaction
 - Collaborative groupware
 - Emergent Learning Objects
 - Tangible and Embodied Interactions
 - "Real time pedagogical logic" (ill determined, un-bound)

Intelligent Agents (Software)

- Coordinate flow of people, groups, activities, materials
- Coordinate ambient displays
- Execute pedagogical scripting logic
 - Process semantic metadata
 - Build and respond to ELOs
 - Resource fetching, distribution
- Examples
 - Bucket agent, Grouping agent
 - Aggregate, Collaborative Group



Scalable Architecture for Interactive Learning (SAIL)



Smart Classroom Environment



Smart Classroom Script



Example: Physics Learning Across Contexts and Environments (PLACE)

- 12-week high school physics. Two classes (n=20, n=25)
- Individual, Collaborative and Collective activities
- User contributed content
 - adding physics examples; creating challenge problems
 - Tagging, commenting on homework problems
- Final Smart Classroom activity: "Solve ill-structured problems"
 - Used Hollywood video clips as reference point
 - Collaboratively set up and solve the video "problems"
- S3 Reference implementation (agent APIs, xml, ambience)

Mike Tissenbaum: Research Questions

- How can smart classrooms reduce the orchestrational load for students and teachers?
- How can intelligent agents support orchestration?
 - Creating emergent learning objects
 - Orchestrating pedagogical logic
 - Fetching, distributing and creating materials
 - Coordinating ambient features
 - support seamless learning across contexts



Scaffolded Inquiry Tools and Materials

| | Watch the video clip | p from a Hollywood movi | e on the large | e video board displaj | <i>I</i> . | | | |
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Personal Tablets: student and teacher

- Scaffolds students at each stage
 - User interface
 - Collaborative learning support
- Guide students to room locations
 - Manage student interaction data (i.e., to S3, agents, etc)
 - Coordinate with teacher tablet
 - "pause the room"
 - On agreement, "advance to next stage"

Scaffolded Inquiry Tools and Materials



Interactive Whiteboards

Dynamic:

- Display depends on learning task and student interactions
- Not just a screen, but a driver of the knowledge construction
- "Public" and collaborative:
 - Aggregate contributions from group
 - Idea negotiation and refinement
 - visual, interactive, and tangible
- Two modes:
 - Group scribble (all tablets drive)
 - Large laptop (one mouse, keyboard)

Physical and Locational Dependencies

- Specific actions, simulations, and tasks are mapped to the physical space (4 video/groups)
- interconnected interactions
 - Students work together at one space or connect ideas across multiple spaces
 - Students move from one location to the next, assigned by agents
- Support growth of ideas
 - Individual displays retain all contributions, ready for next group to take over.



Ambient Awareness – at a glance Showing teachers and students "Where we are"

- Large, central display shows current location and movement of students in the room
- Icons next to student avatars show tasks completed by each student
- Coloured bar at the top shows timing of individual tasks



PLACE Video



http://vimeo.com/64465522

Example Two: EvoRoom

- 12-week high school biology. Two classes (n=20, n=22)
- Mix of contexts (classroom, home, zoo, smart room)
- Research Focus of Smart room : Immersive environment
- Challenges for Immersive Smart room:
 - Find a topic that allows for deep scientific learning (complex, engaging) = "evolution and biodiversity"
 - to connect the experience in the room to a broader curriculum
 - To design materials that promote interactions

Michelle Lui: Research Questions

- How can immersive, room-sized simulations support collective inquiry?
- What interaction patterns support knowledge coconstruction?
- How should such simulation activities be embedded within the broader curriculum?
 - To support learning and instruction
 - To ensure that its not just a motivating "supplement"



Smart classroom



EvoRoom

- Large screen projections around the room display the immersive simulation, together with audio tracks of natural rainforest sounds
- Transform a smart classroom into a rainforest in Southeast Asia.
- Students are carefully scripted to make observations of whether individual species are present in the environment, and evaluate large cladogram (Emergent Learning Object)



Emergent Aggregates of Community Knowledge

- Embodied, immersive experience of rainforest over 200 million years
- distributed pedagogical design
- Community produces knowledge artifacts (e.g., cladogram)
- Students and teacher use the artifact in subsequent activities





Representation is a clear, dynamic product of their interactions

- A resource belonging to, representing their community's progress
- Provides a target for student inquiry and teacher discussions



http://vimeo.com/63296638

Phase 3 Discussion

Questions

- How can highly networked technologies and realtime messaging add new capabilities for scripting?
- What risks are there for "over-scripting"
- What new opportunities are there for leveraging

Discussion

- Learning progressions within a KCI script
 - Student inquiry trajectories (individual, collaborative)
 - Discourse practices (technology mediated knowledge building)
- Epistemic Cognition within KCI script
 - Interplay between technology, pedagogy and epistemic commitments
- Tangible and Embodied Learning
- Online Learning, MOOCS, etc
- 21st century schools,
- ??