

Conceptual Framework for Knowledge Building Analytics

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Outline

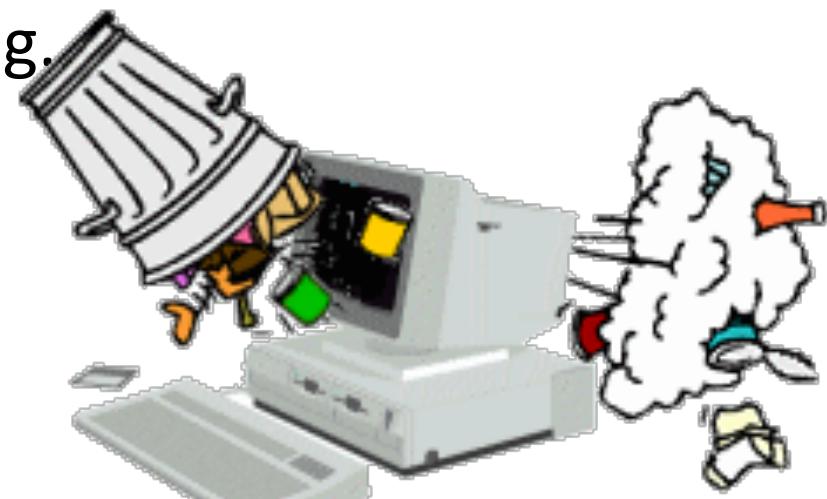
- Understanding KB analytics
- Analyzing KB as a multi-level emergent system
- Examples of KB analytics in levels

Learning vs. Knowledge Building Analytics

- Learning/knowledge building analytics is the measurement, collection, analysis and reporting of data about learners/knowledge builders and their learning/knowledge building processes in contexts, for purposes of understanding and optimizing learning/knowledge building and the environments in which it occurs.
- Difference btw. Learning and KB
 - **Learning** is an internal process that results in changes of beliefs, attitudes, or skills.
 - **Knowledge building** is a process of creating and advancing public/community knowledge: knowledge outside the mind

Theory-Guided Analysis

- Vast data, diverse analysis tools
- Avoid “garbage in, garbage out,”
- We need conceptual frameworks to guide:
 - what data to input,
 - to output what patterns,
 - for what purpose/meaning.



From Knowledge-based to Choice-based Assessment

- “At the end of the day, whether a student has “good knowledge” will be crucial only to the degree that knowledge leads to good choices, so why not measure choices directly in educational assessments? ”

Measuring What Matters Most (Shwartz & Arena)

Knowledge Building as a Multilevel Emergent System

- Social emergence: The emergence of KB collaboratives from members' interactions
 - from individuals to emergent groups (social knots), community-wide interaction (across groups), inter-community networks
- Epistemic emergence: The emergence of “big ideas” (core conceptualizations and frameworks of thinking) from micro idea interactions
 - Idea contributions → insights from an idea thread → advances from idea thread clusters → “big ideas” across clusters/areas

(Sawyer, 2005; Stahl, 2013; Hong et al., 2010; Zhang, 2012; Zhang et al., 2009).

Essential to Both Social and Epistemic Emergence...

- Temporal dynamics:
 - The current roots in the past and seeds the future
 - Levels of timescales from micro (e.g. one episode, lesson) to macro (whole initiative, longer trajectories of work)
- Micro-macro links:
 - Existing/ongoing micro interactions give emergence to macro collective social and conceptual structures
 - Macro collective structures have downward impact on micro interactions
 - Macro structures are often not visible to the participants
 - View each level in the context of the higher and lower levels (Lemke, 2000)

Theory-Guided Data Sampling/Sorting

- We need time-marked socio-epistemic data about KB
- Organized based on multiple units/levels of the KB system
 - Individual idea/posting contributed by a member
 - A build-on tree contributed by several immediately connected peers
 - An idea thread (line of inquiry) by an opportunistic group sharing the same interest
 - A cluster of idea threads by several overlapping groups
 - A whole initiative with multiple clusters of idea threads of a community
 - Interrelated initiatives in an area of multiple communities

Theory-Informed Patterns as the Output of Analysis

- **Patterns nested in different socio-epistemic levels (units)**
 - “Person-idea”: What’s my focus of choice? How have I been contributing?
 - Ways of contribution, such as problematizing, theorizing, elaborating, referencing, evidence use, synthesizing...
 - “Sub-Group-idea thread”: What are our shared focus of choice? How are we advancing ideas in a focal line of work?
 - Focal topics and associated contributions and contributors, progressive chain of problems and ideas, interactivity, conceptual change, idea summarization
 - “Community-thread cluster”: How are we building knowledge as a community in a whole initiative?
 - Idea thread mapping, topic/concept networks (clouds), social networks, inter-thread connection, diffusion/transfer of core conceptions
 - “Network-domain/field”: How has a network of communities been advancing ideas in a shared domain/field?
 - Cross-community topic/concept mapping, idea thread matching, idea and practice bridging/borrowing

Integrating Multiple Dimensions for Each Unit/Level of Analysis

To understand/create **what**, with what findings (epistemic goals, focuses, and outcomes)

Who, with whom (social)

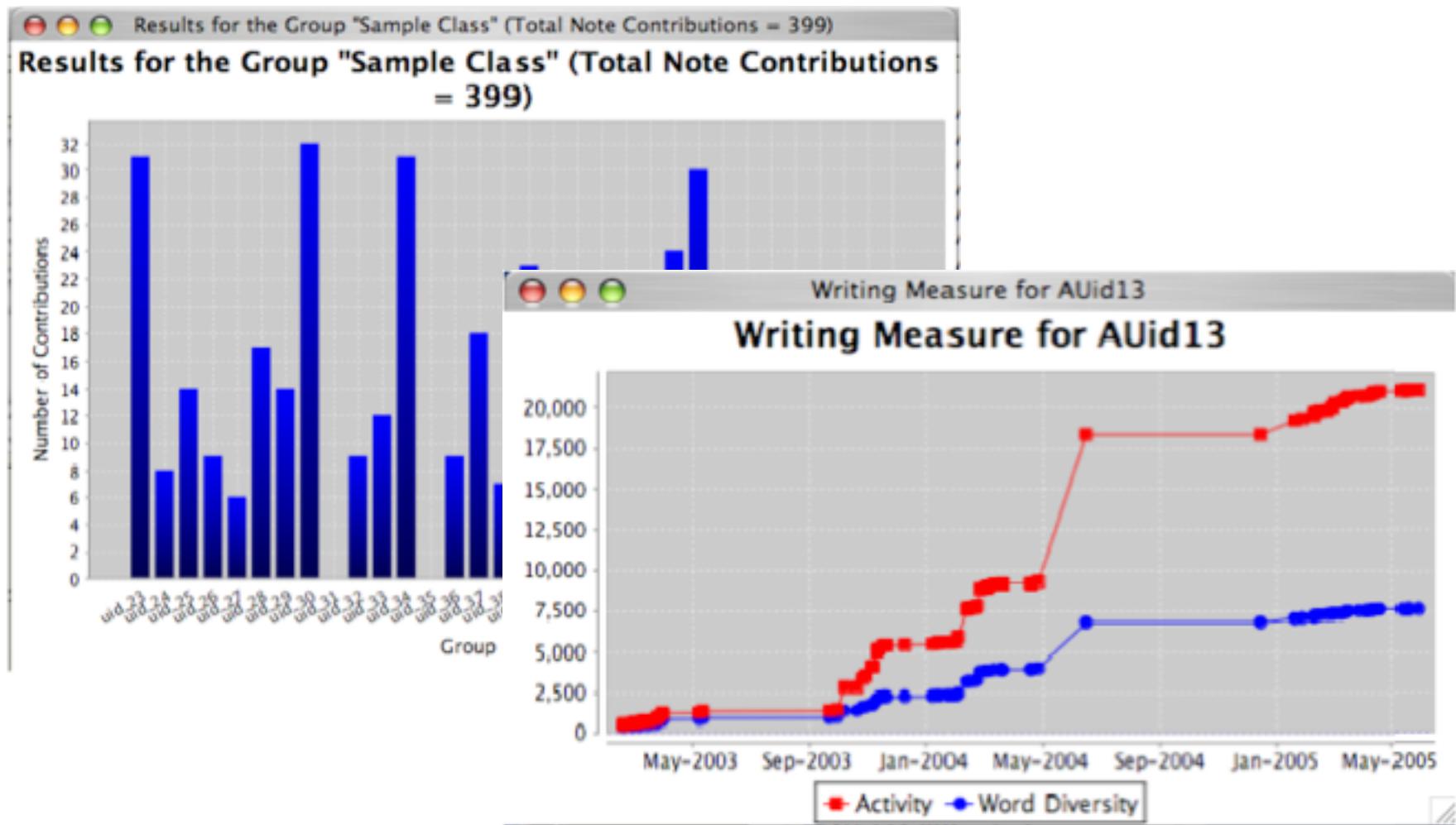
How (ways of contributing and interacting)

When (Temporal: focal/current, in relation to before/after)

Emergent units of analysis

- Network-domain
- Community-thread clusters
- Group-idea thread
- Person-idea

Individual “Person-idea”: How have I been contributing?



(Teplovs, Donoahue, Scardamalia, & Philip, 2007)

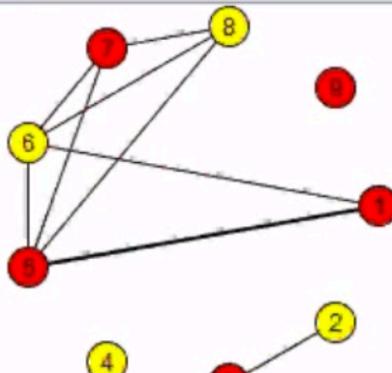
Discourse - SampleDiscourse(English)

View

...	Id	N...	Text
5	6	A3	Right, exactly. So, first for the electron we use Planck/mass velocity
6	7	A1	We need to find the mass of an electron .
7	8	A3	No, we know the mass of an electron . It's an electron .
8	9	A1	Very true, very true
9	...	A3	But we don't know...
...	...	A1	With this wavelength we would be find velocity
...	...	A2	What did they give us. For the following wavelength . So, well lambda
...	...	A1	Yes, its tell us to use lambda equal Planck/mass velocity .
...	...	A1	You can find energy-k .
...	...	A3	energy-k of a photon.
...	...	A1	Use energy-k of the-work-function equal [sic] energy-k equal Planck

Network - Discourse Units

File View Metrics ScreenShot



Circle

Set - <-> + - V +

Network - Students

File View Metrics ScreenShot

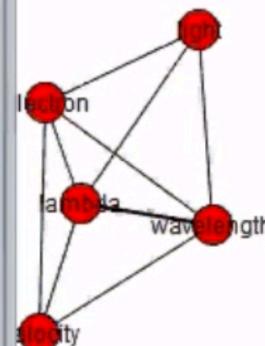


Circle

Set - <-> + - V +

Network - Words

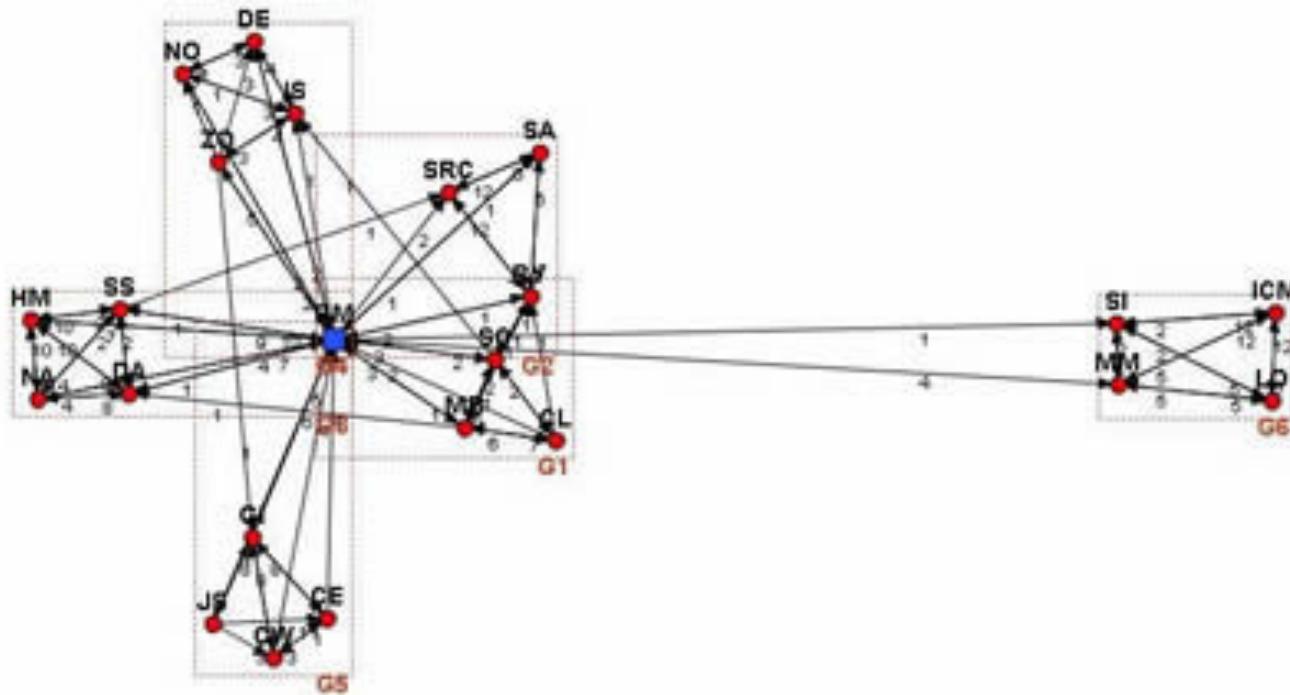
File View Metrics ScreenShot



Fruchterman-Reing... Set - <-> + - V +

The framework suggests that these analyses can be embedded in high levels and integrate multiple dimensions: contributions and promising ideas in which area/line of work, about what content, from whom, when...

Emergent Group-Idea Thread



Analyze sub-networks (cliques and clusters) in SNA

Zhang et al., 2009

Future efforts to connect social cliques with other dimensions such as what, when...

Emergent Group-Idea Thread

Update Idea Thread: Underwater Plants
Project: Plants

Find More Notes Journey of Thinking Rename Thread Delete Thread Save and Close

This thread includes 22 note(s) by 13 author(s)

| Hide Title | Show Author | Hide Build-on | Show Reference |

Thread Visual

Underwater Plants

air

water and oxygen

Underwater Plants

potion

plants

underwater bre

plants adaptng

experiment

best places for plants to live

death and life

different steps

Note Title list

plants adaptng (View:Aquatic and Desert Plants)

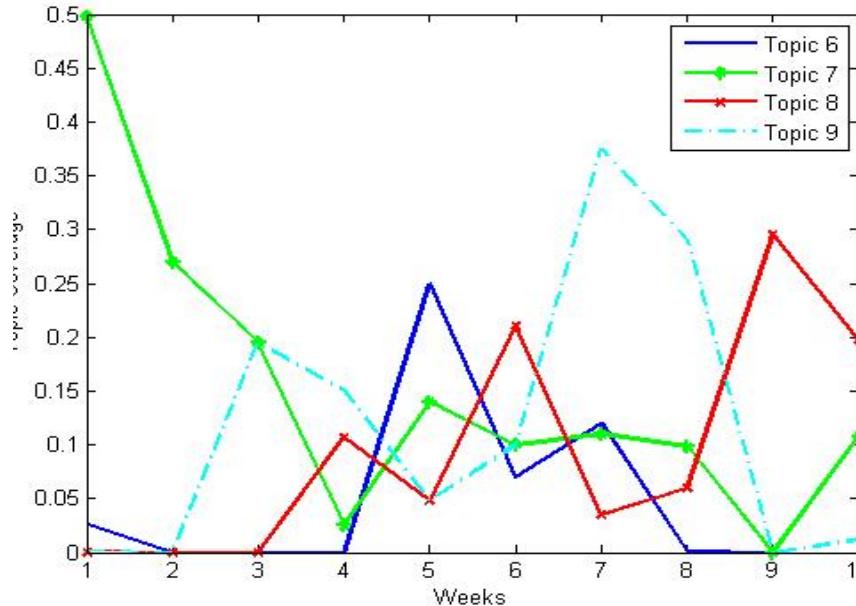
By: [REDACTED] At : 2012-03-30 10:04

I think the under water plant gets about as much food and water as plants on land have so they don't have to adapt that much. For instance they still get sun and water but they just have to adapt to the under water creatures and putting their roots in the under water ground. Like animals I think they can adapt.

Note Content

Emergent Group-Idea Thread

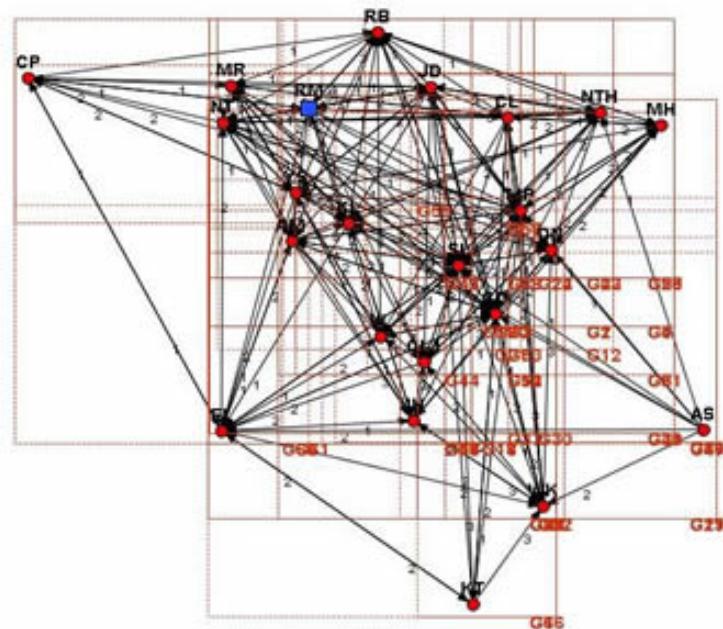
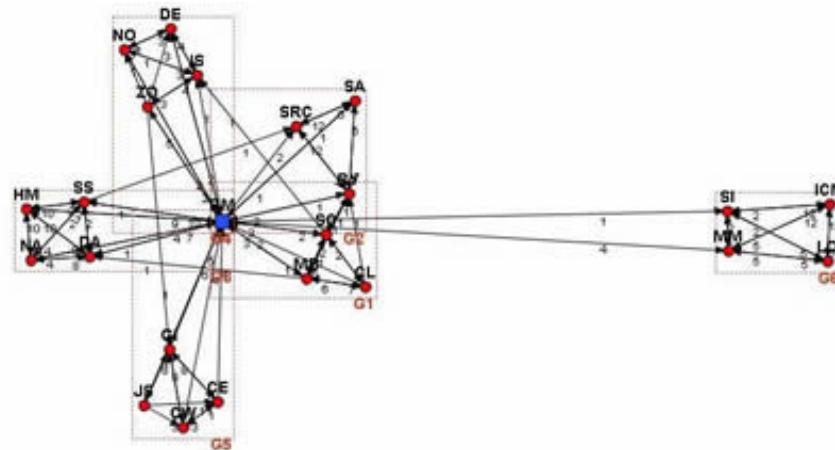
Probabilistic Topic Models (Sun et al., 2014)



Topic 6	'sun' 'when' 'earth' 'moon' 'eclipse' 'shadow' 'other' 'world' 'around' 'line' Eclipses and seasons	Eclipses and seasons
Topic 7	'white' 'snow' 'colour' 'prism' 'black' 'melt' 'when' 'see' 'fast' 'why'	White light and snow
Topic 8	'shadow' 'object' 'made' 'opaque' 'energy' 'part' 'call' 'umbra' 'what' 'go' Shadows and light sources	Shadows and light sources
Topic 9	'through' 'go' 'can' 'reflect' 'tinfoil' 't' 'think' 'was' 'angle' 'when'	Reflective materials

Whole Community-Thread Clusters

- Network Centrality, Cohesion...

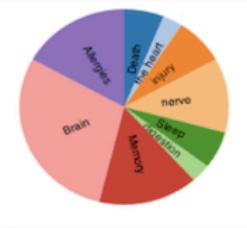
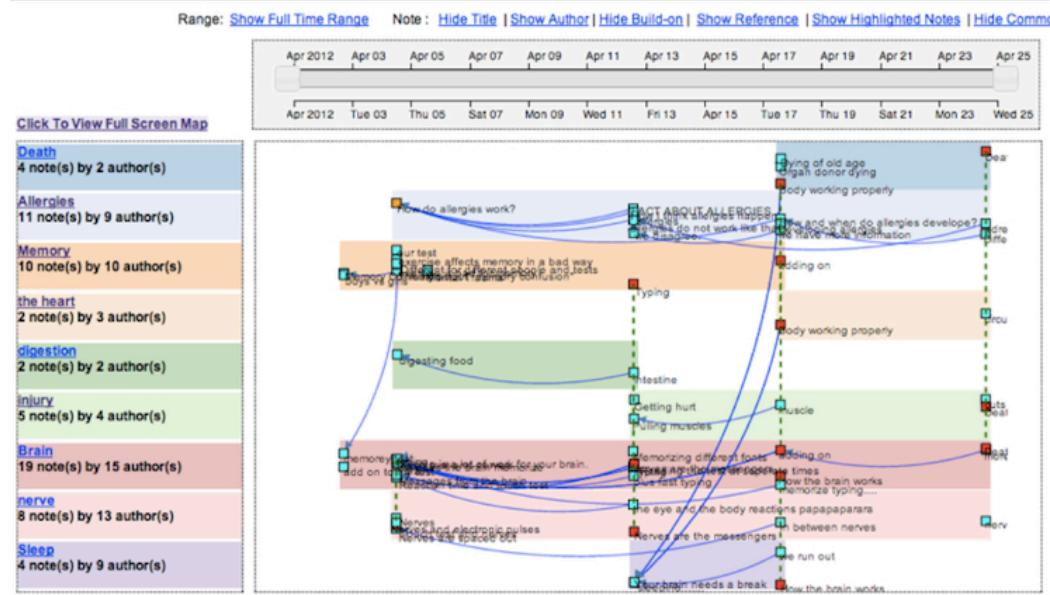


From more centralized to more distributed and coherent networks (Zhang et al., 2009)

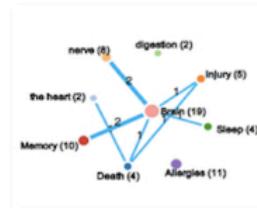
Whole Community-Thread Clusters



You are working on Project: [Human Body \(Ben 5/6\)](#) (Teacher: Ben, School Year: 2011 to 2012) This project has 9 idea thread(s). Click "Thread" to add or view/edit threads. Click "Map" to show threads.



Example analyses: Distribution of notes in threads



Cross-thread connection

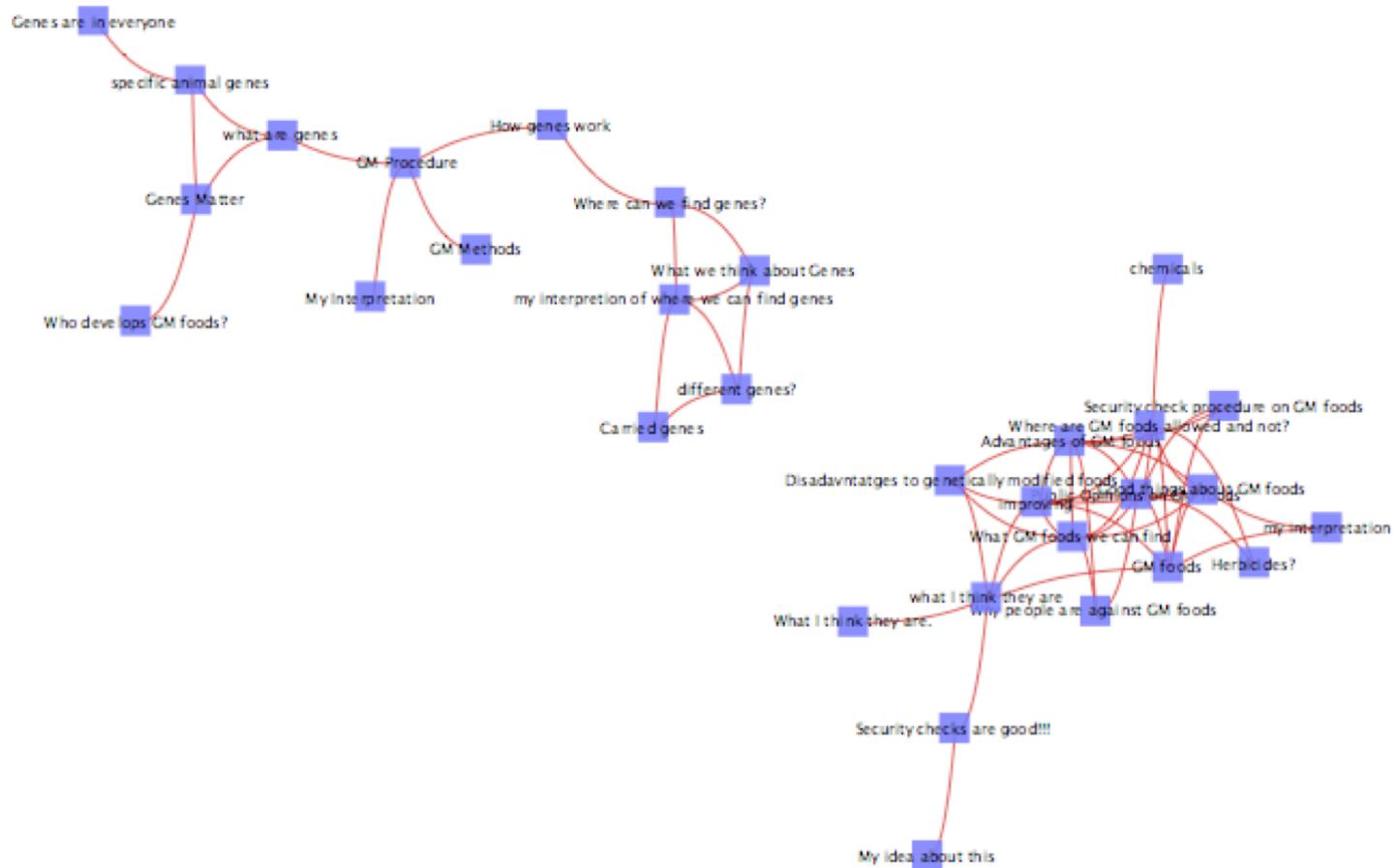
Whole Community-Thread Clusters

- Community knowledge represented by key-term cloud in a grade 5/6 class exploring human body system (Hong & Scardamalia, 2014)

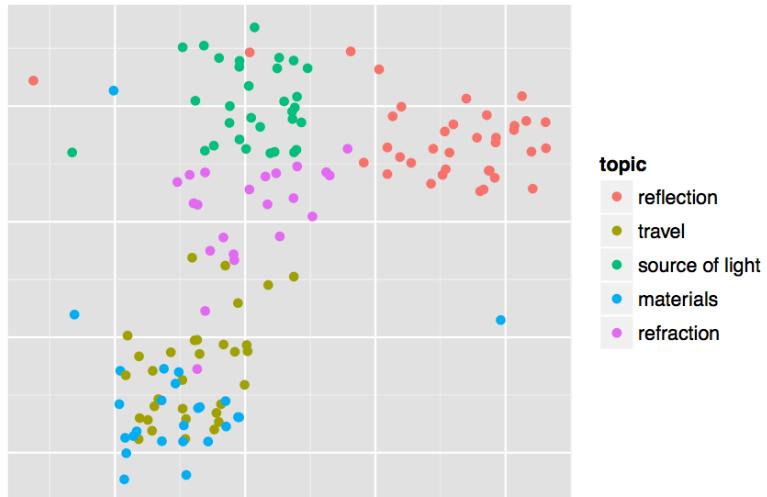
alcohol allergic allergy animal ankle antibodies aorta arm arteries arthritis babies baby bacteria ball ball and socket joint bird birth blood blood cell blood sugar blood transfusion blood vessel bodies **body** bone booger brain brain imaging brain tumor break break down breath breathe brittle broke bruise calcium cancer carbohydrate carbon dioxide cartilage cast cell chamber chromosome clog cloning cold collar bone connection contagious disease cord core of red marrow cough crack crush current cut damage defense diabetes diaphragm die digest disease disorders doctor down syndrome dream drink ear eat ellipsoidal embryo embryonic stem cell energy erythrocytes evolve exercise facial fat feel fever fight fight disease flat bone flow fluid food foot fracture gene genetic germ glucagon grow grow hair hand head headache heal heart hemoglobin hereditary hinge joint hormone hot human hungry iamese ice illness immune system inject injury insulin intestine joint kill kiss knee knuckle learn leg liquid lisp live liver liver disease long bone lump lung lymph lymph gland lymph node lymphatic system lymphocyte lysosome macrophage marrow medicine membrane memories memory task men message milk mind mineral mitochondria monkey mononucleosis mouth muscle neck nerve neutron nose nucleus numb number nut nutrient organ oxygen pain pancreas paralyze parent pathogen people periosteum phagocyte pivot plane joint power pump rat red marrow reflex remember reproduce rib rub saliva salt scientist see sense shoulder sick signal skin skull sleep small intestine sneeze speed spine spongy bone spread steel stomach strength stress sweat swollen teeth tired toe tongue touch triplet tumor twin upright vein villi virus walk water weak weight white cell womb women

- Future efforts need to connect word clouds to other dimensions: who, when, how (ways of contribution)...

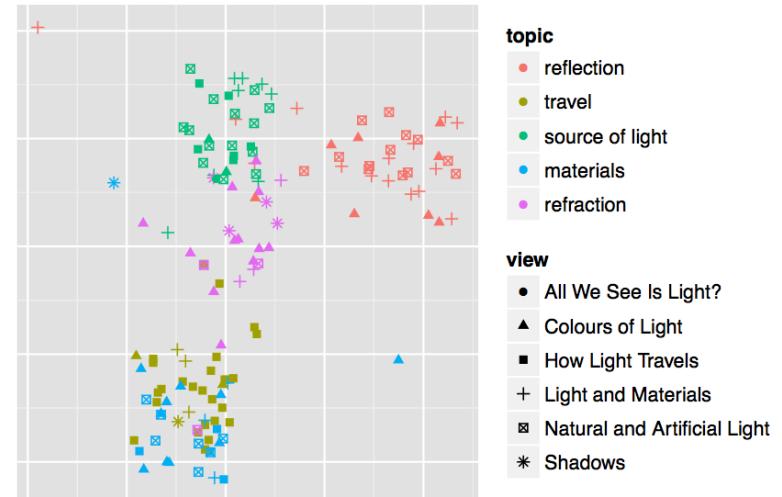
Semantic links among notes (Teplovs, 2010)



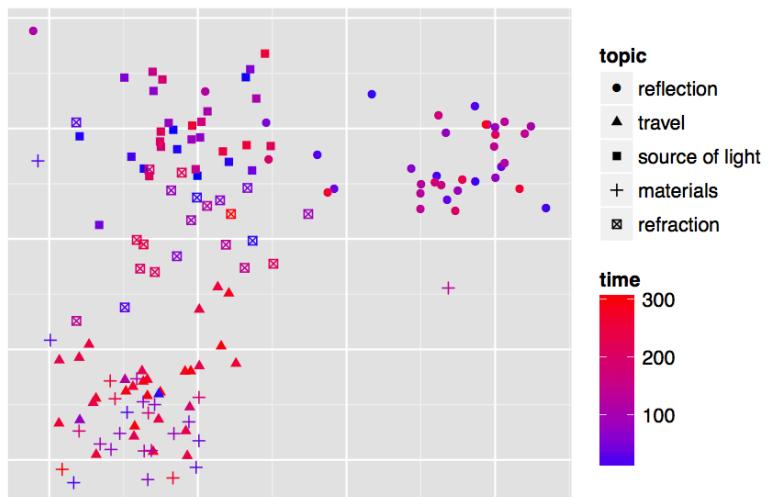
Explorations of visualizing semantic space by different variables (Chen, 2014)



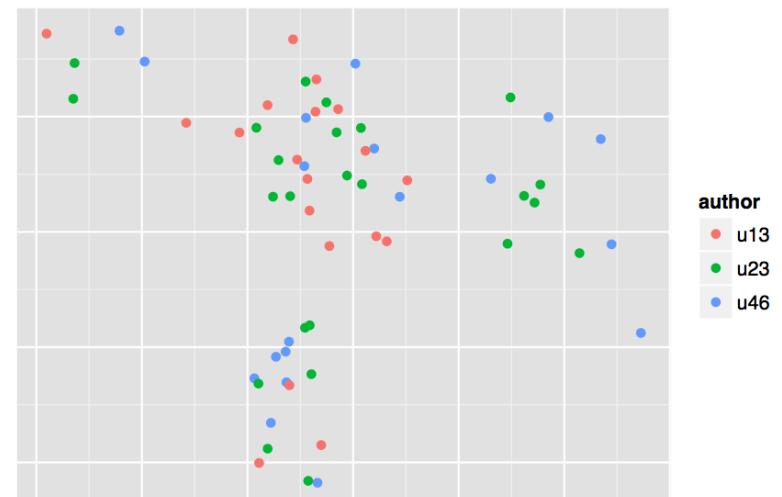
(1) By topics (top 5 topics)



(2) By topics and views



(3) By time



(4) By students (top 3)

Inter-community networks-Knowledge Domains

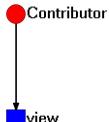
KSN as an example (Hong, Scardamalia, Zhang, 2010)

Legend

A red-circled node = a contributor

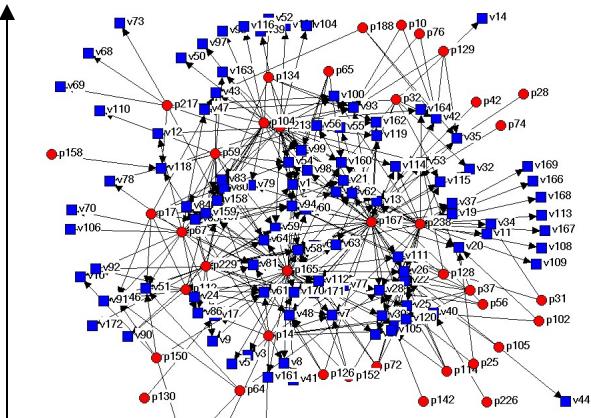
A blue-squared node = a view

Tie= strength of knowledge-building (note contribution from a contributor to a view) as measured by the unit of analysis:

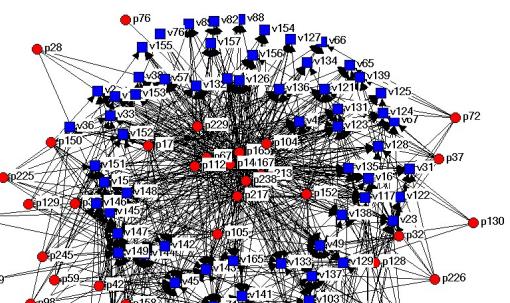


Strong
Collaboration

Weak
Collaboration



Weak
Knowledge-interaction

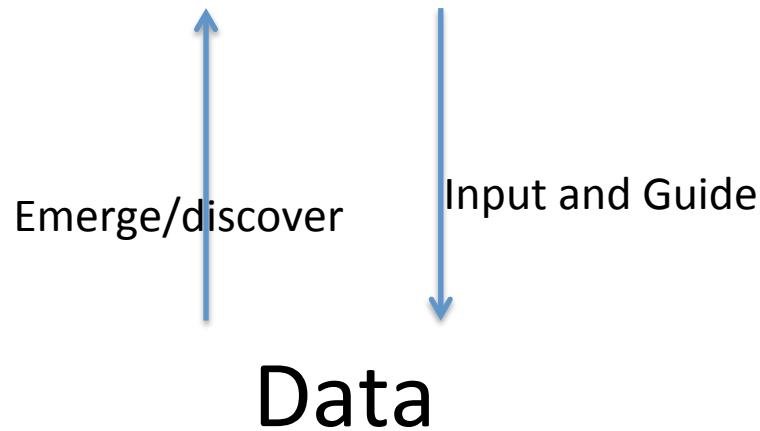


Strong
Knowledge-interaction

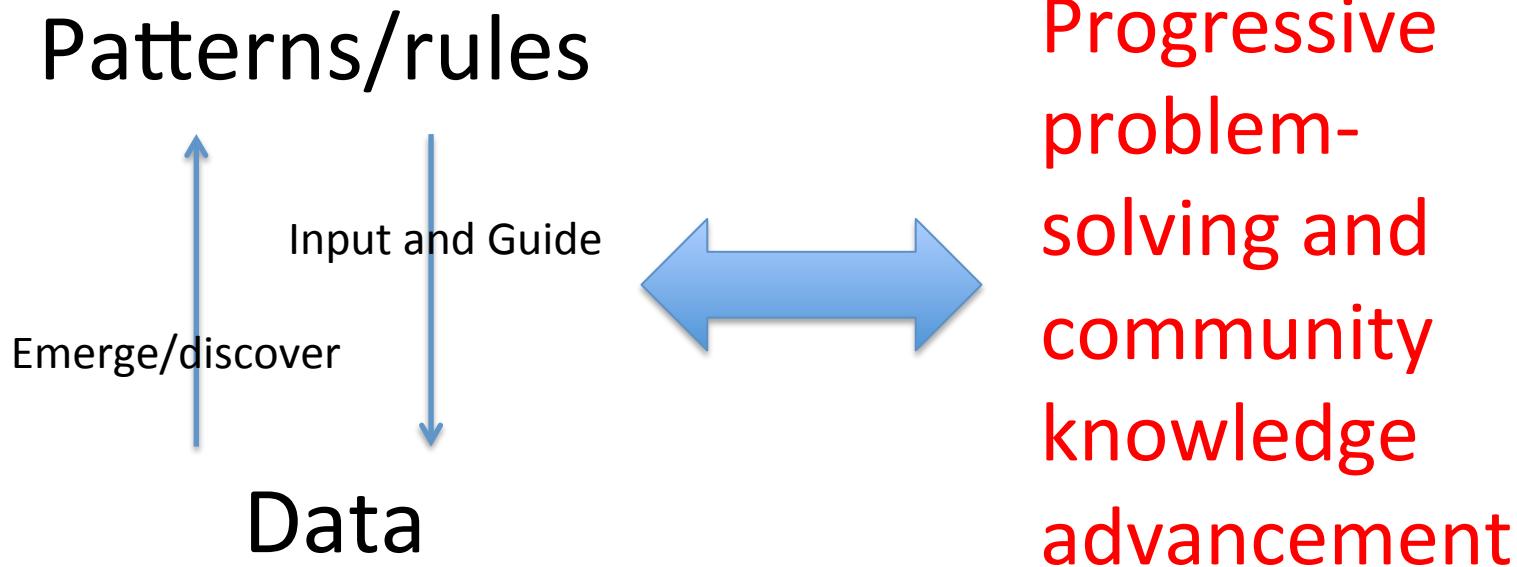
Future efforts: open data and make visible of which community (who) is advancing what knowledge

Integrating Bottom-Up and Top-Down Processes

Patterns/rules



Integrating Bottom-Up and Top-Down Processes



General discussion

- Data is not neutral
- KBE is not neutral
- How to conceptually integrate various KB measures into more coherent higher-level KB indicators?
- How to technologically link different KB analytic tools for more sophisticated use of knowledge advancement?

Thanks!

For What Purpose/Use?

- Reflective feedback
- Formative assessment
- Summative assessment
- Emergent representation of epistemic and social structures across the different levels
 - Shared goals
 - Practice profiles (e.g. ways of contributing and interacting)
 - Collective knowledge and trajectories
 - Sub-community structures
 - Idea-person connections
 - Cross-community connections