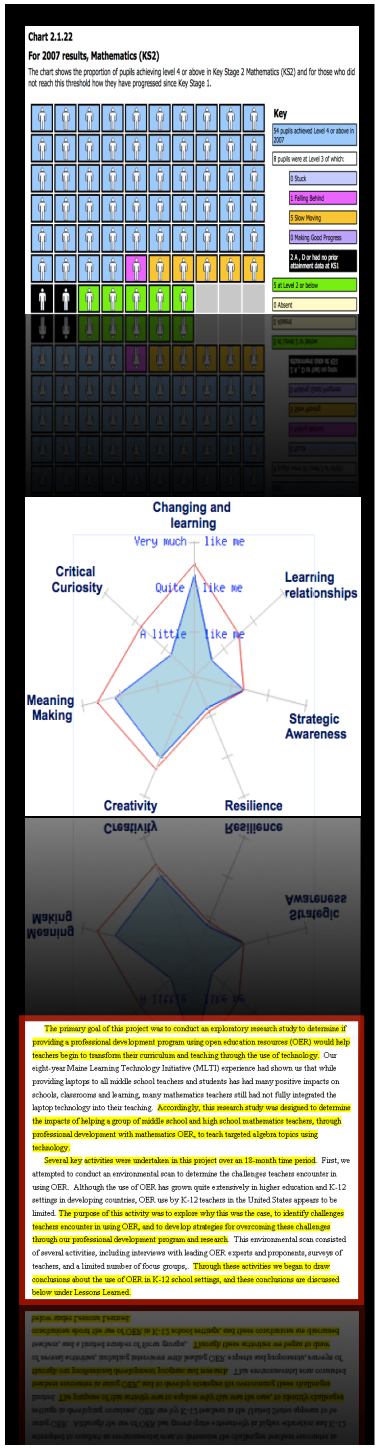


Learning Analytics & Knowledge 2011, Banff, Canada

The Open University

Theory-based Learning Analytics:

Notes & Examples from Learning & Sensemaking

Simon Buckingham Shum

Knowledge Media Institute
Open University UK

http://simon.buckinghamshum.net
http://open.edu
@sbskmi

KMi: near future (3-5 years) infrastructure for Open U, and other knowledge-intensive orgs

KNOWLEDGE MEDIA

KMi

INSTITUTE

http://kmi.open.ac.uk

Theory and Technology at the intersection of Hypertext and Discourse

http://projects.kmi.open.ac.uk/hyperdiscourse

Projects span many disciplines, ranging from basic research to applications:

theory ~ analytics

examples

theory ~ analytics

?

“theory-based analytics”

?

Premise: ANY analytic is an implicit theory of the world, in that it is a model, selecting specific data and claiming it as an adequate proxy for something more complex

“theory-based analytics”

So for “Theory”, let’s include assumptions, as well as evidence-based findings, statistical models, instructional methods, as well as more academic “theories”

“theory-based analytics”

The question is whether this has INTEGRITY as a meaningful indicator, and WHO/WHAT ACTS on this data

A theory might tell you WHAT to attend to as significant/interesting system behaviour.

“theory-based analytics”

The analytics task is to meaningfully MINE from data, or ELICIT from learners, potential indicators in a computationally tractable form

A mature theory will tell you WHY a given pattern is significant system behaviour.

“theory-based analytics”

This might help in guiding how to MEANINGFULLY, ETHICALLY PRESENT ANALYTICS to different stakeholders, aware of how they might react to them

A mature theory validated by pedagogical practices will tell you APPROPRIATE INTERVENTIONS to take given particular learner patterns

“theory-based analytics”

If formalizable, analytics might then be coupled with recommendation engines or adaptive system behaviours

A theory can shed new light on familiar data

“theory-based analytics”

This might equate to reinterpreting generic web analytics through a learning lens

A theory might also predict future patterns based on a causal model

“theory-based analytics”

This might be formalizable as a predictive statistical model, or an algorithm in a rec-engine

Example

RAISEonline: learning analytics in English schools

RAISEonline (English schools)

Literacy, Numeracy & Science can be measured in controlled, written examinations, designed by experts for the whole country

“theory-based analytics”

Analytics can be generated from test scores in order to meaningfully compare schools in national league tables, accounting for different contexts

Learning analytics in English schools

Ofsted department for children, schools and families

Contextual Value Added Key Stage 1 to 2 : by subject

Analysis in this section focuses on the contextual value added for the National Curriculum core subjects (English, mathematics and science) in the current year. For all of the subject-based CVA analysis, prior attainment used in the CVA models was based on a combination of reading, writing and mathematics at Key Stage 1. A 95% confidence interval is shown. Where the confidence interval does not cross the national average line the school value differs significantly from that national average.

Chart 2.1.12

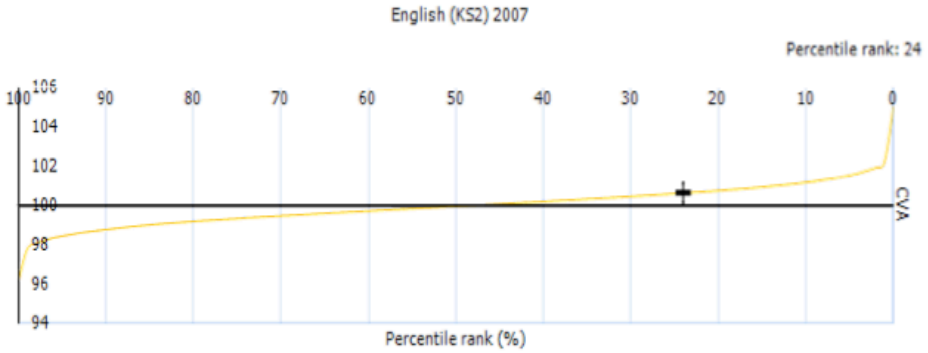
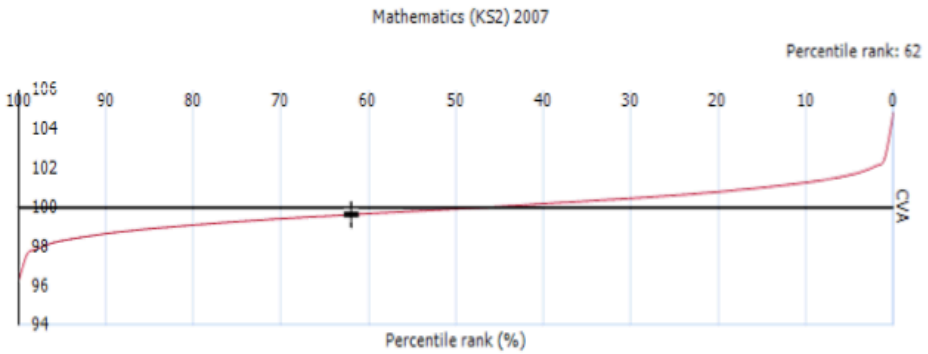


Chart 2.1.13



English	**Cohort for CVA**	72	76	64
	CVA School score	97.4 ↓	98.9 ↑	100.6 ↑
	95% confidence interval +/-	0.5	0.5	0.5
	Significance	Sig-	Sig-	Sig+
	Percentile rank	100	87	24
	Coverage	94%	94%	96%
Mathematics	**Cohort for CVA**	71	76	64
	CVA School score	98.4	98.6	99.6 ↑
	95% confidence interval +/-	0.6	0.6	0.6
	Significance	Sig-	Sig-	
	Percentile rank	93	91	62
	Coverage	92%	94%	96%

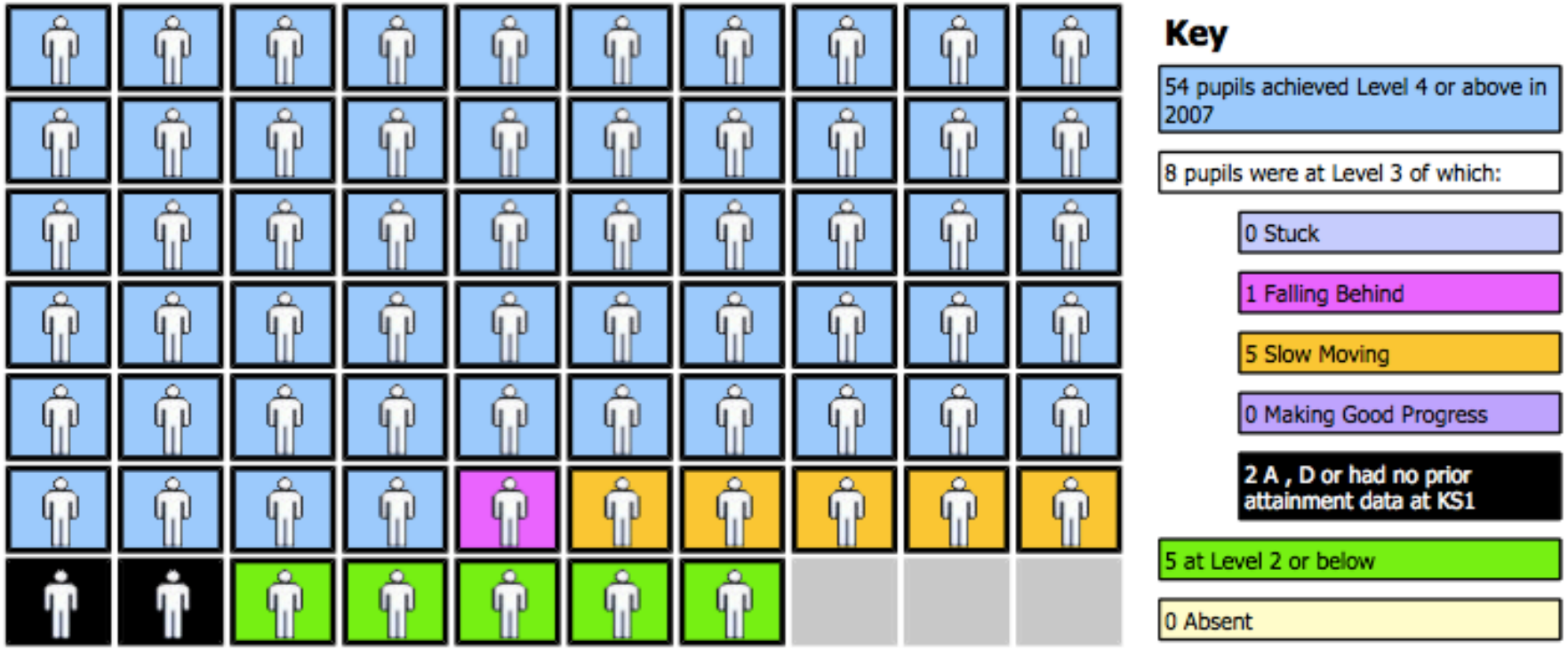
Learning analytics in English schools

Ofsted department for children, schools and families

Chart 2.1.22

For 2007 results, Mathematics (KS2)

The chart shows the proportion of pupils achieving level 4 or above in Key Stage 2 Mathematics (KS2) and for those who did not reach this threshold how they have progressed since Key Stage 1.



Example

Open U’s analytics

OU Analytics

Years of data reveal significant patterns between student study history, demographics and outcomes

“theory-based analytics”

We can formalize these, eg. as organisational good practices around student support, or as statistical models to reflect on actual vs predicted course outcomes

OU Analytics service: Effective Interventions

- **Proactive measures targeted at specific points in the student journey are associated with improved retention and progression**
  - Telephone contact with students considered to be potentially ‘at risk’ before the start of their first course is associated with around a 5% improved likelihood of course completion.
  - Additional tutor contact mid-way through a course is associated with between 15% to 30% improved likelihood of course completion.
  - Additional tutor contact around course results is associated with between 10% to 25% improved likelihood of registering for a further course.
  - Contact with students intending to withdraw before course start is associated with retaining 4% of students on their current course.

OU Analytics service: Predictive modelling

- **Probability models help us to identify patterns of success that vary between:**
  - student groups
  - areas of curriculum
  - study methods
- **Previous OU study data – quantity and results – are the best predictors of future success**
- **The results provide a more robust comparison of module pass rates and support the institution in identifying aspects of good performance that can be shared and aspects where improvement could be realised**

Example

sensemaking in complex problems

It's all about *Sensemaking*

"Sensemaking is about such things as placement of items into frameworks, comprehending, redressing surprise, constructing meaning, interacting in pursuit of mutual understanding, and patterning."

Karl Weick, 1995, p.6

Sensemaking in Organizations

Sensemaking in complexity

Individual and collective cognition has known limitations in dealing with complexity and information overload

“theory-based analytics”

Collective intelligence tools and analytics should be designed specifically to minimise breakdowns in sensemaking

Sensemaking in complexity

Complexity ~ sensemaking phenomena	Focus for analytics/rec-engines?
Risk of entrained thinking from experts who fail to recognise a novel phenomenon	• Pay particular attention to exception cases • Scaffold critical debate between contrasting perspectives on common issues

Sensemaking in complexity

Complexity ~ sensemaking phenomena	Focus for analytics/rec-engines?
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Complex systems only seem to make sense retrospectively	• Use narrative theory to detect and analyse knowledge-sharing/interpretive stories • Coherent pathways through the data ocean are important

Sensemaking in complexity

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Complex systems only seem to make sense retrospectively	• Use narrative theory to detect and analyse knowledge-sharing/interpretive stories • Coherent pathways through the data ocean are important
Much of the relevant knowledge is tacit, shared through discourse, not formal codifications, and trust is key to flexible sensemaking when the environment changes	• Scaffold the formation and maintenance of quality learning relationships
	Recommend based on different kinds of significant conceptual/social connections

Buckingham Shum, S. and De Liddo, A. (2010). Collective intelligence for OER sustainability. In: *Open Education: Seventh Annual Open Education Conference*, 2-4 Nov 2010, Barcelona, Spain. Eprint: http://oro.open.ac.uk/23352

Sensemaking in complexity

Complexity ~ sensemaking phenomena	Focus for analytics/rec-engines?
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Complex systems only seem to make sense retrospectively	• Use narrative theory to detect and analyse knowledge-sharing/interpretive stories • Coherent pathways through the data ocean are important
Much of the relevant knowledge is tacit, shared through discourse, not formal codifications	• Scaffold the formation and maintenance of quality learning relationships
Many small signals can build over time into a significant force/change	• Highlight important events and connections → aggregation and emergent patterns • Recommend based on different kinds of significant conceptual/social connections

Buckingham Shum, S. and De Liddo, A. (2010). Collective intelligence for OER sustainability. In: *OpenEd2010: Seventh Annual Open Education Conference*, 2-4 Nov 2010, Barcelona, Spain. Eprint: http://oro.open.ac.uk/23352

Example

learning-to-learn analytics

- **“We are preparing students for jobs that do not exist yet, that will use technologies that have not been invented yet, in order to solve problems that are not even problems yet.”**

“Shift Happens”
http://shifthappens.wikispaces.com

Learning Power

There is a set of generic dispositions and skills characteristic of good learners. If learners can be taught a language for these, they can get better at 'learning-to-learn' across many contexts

"theory-based analytics"

Analytics can be generated from a self-report questionnaire, validated through good mentoring — and possibly from online behaviour, demonstrating improvements in L2L

Learning to Learn: 7 Dimensions of "Learning Power"

Expert interviews + factor analysis from literature meta-review: identified seven dimensions of effective "learning power", since validated empirically with learners at many stages, ages and cultures (Deakin Crick, Broadfoot and Claxton, 2004)

Being Stuck & Static	⟷	**Changing & Learning**
Data Accumulation	⟷	**Meaning Making**
Passivity	⟷	**Critical Curiosity**
Being Rule Bound	⟷	**Creativity**
Isolation & Dependence	⟷	**Learning Relationships**
Being Robotic	⟷	**Strategic Awareness**
Fragility & Dependence	⟷	**Resilience**

www.vitalhub.net/index.php?id=8

Learning to Learn: 7 Dimensions of Learning Power

Resilience

Definition

Resilient learners like a challenge. They accept that everyone can find learning hard sometimes and are not frightened by finding something difficult. They have a high degree of 'stickability'. They are not fragile and can tolerate the feelings of anger, fear, frustration and anxiety that sometimes accompany learning.

Strategic awareness

Definition

Strategic learners think about how they learn. They talk about how they will go about something and consider the habits, preferences, strengths and weaknesses they bring to the task. They are aware of their own feelings about learning and know how to manage them. They can talk about personal learning preferences.

Critical Curiosity

Definition

Effective learners in this dimension like to delve deeper to find out what is going on. They like to 'get at the truth' by asking questions such as Why? What? When? Where? How? etc.

They are less likely to accept information uncritically or just because someone says so.

Creativity

Definition

Creative learners are playful, they like a challenge and are willing to take risks. They like to look at a problem from many different perspectives and will use their imagination, letting their mind 'float free' to find creative solutions. They listen to their intuition and follow hunches in their learning.

www.vitalhub.net/index.php?id=8

Learning to Learn: 7 Dimensions of Learning Power

Meaning Making

Definition

Students who effectively make meaning can link information between subject areas and across learning contexts. They connect learning at home with learning in school and learning from previous years with learning occurring now. Effective learners in this dimension engage their own values and stories in learning and create personal relevance from information they learn.

Learning Relationships

Definition

Learners who have quality learning relationships find it useful and exciting to share thoughts and ideas with others, yet they can work equally effectively on their own. They make good use of adult sources of support and guidance at home and in the community. They draw on their community's worldviews and traditions.

Changing and Learning

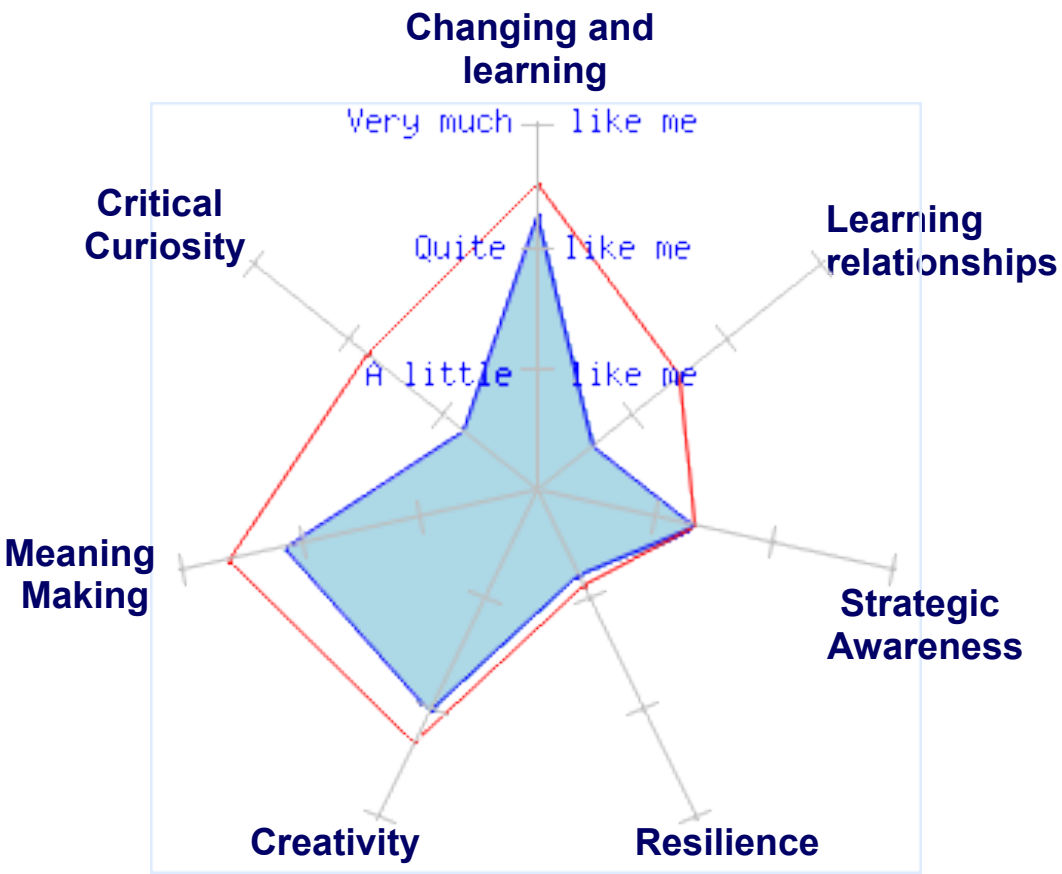
Definition

Learners who are strong in this dimension know that learning is learnable. They believe that through effort their minds can get bigger and stronger just as their bodies can. They gain pleasure and self-esteem from expanding their capacity to learn.

www.vitalhub.net/index.php?id=8

Analytics tuned to Learning Power: ELLI

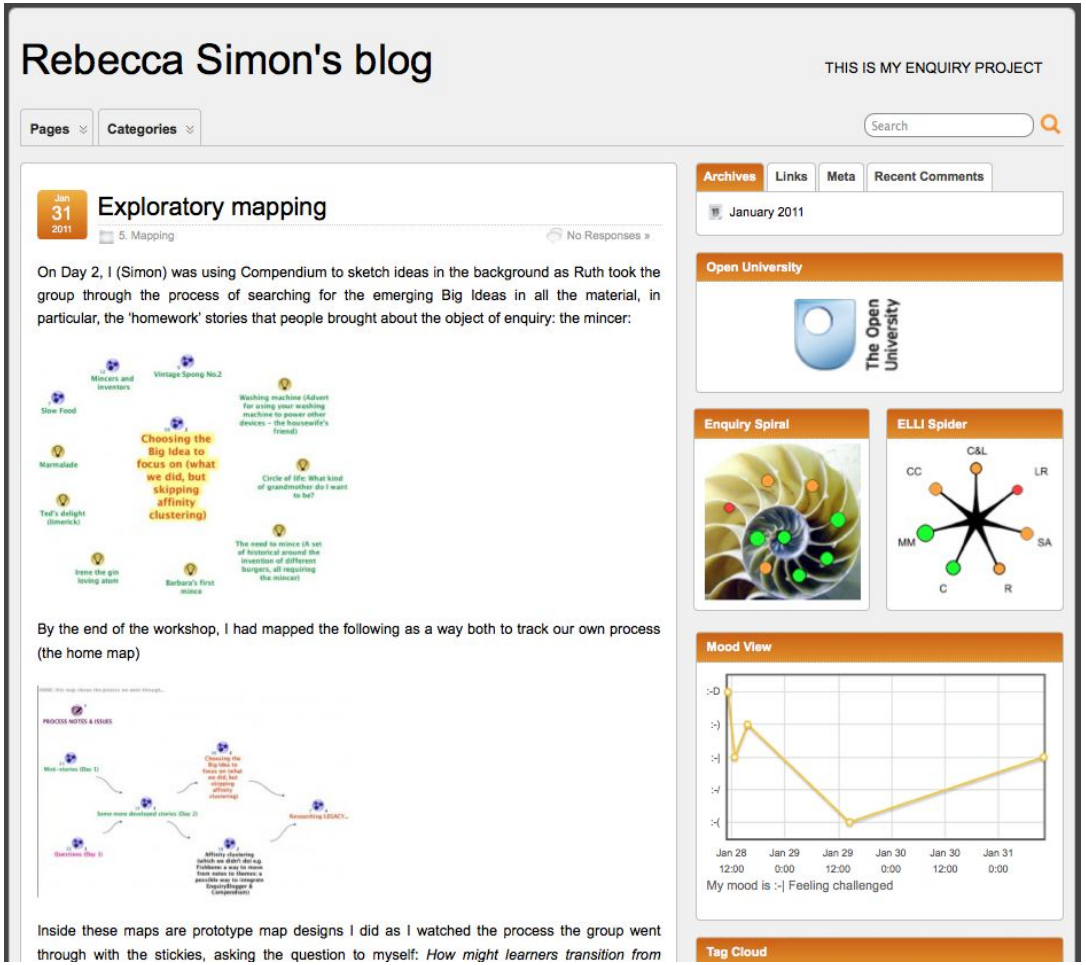
ELLI: Effective Lifelong Learning Inventory (Ruth Deakin Crick, U. Bristol)
A web questionnaire generates a spider diagram summarising the learner's self-perception: the basis for a mentored discussion and interventions



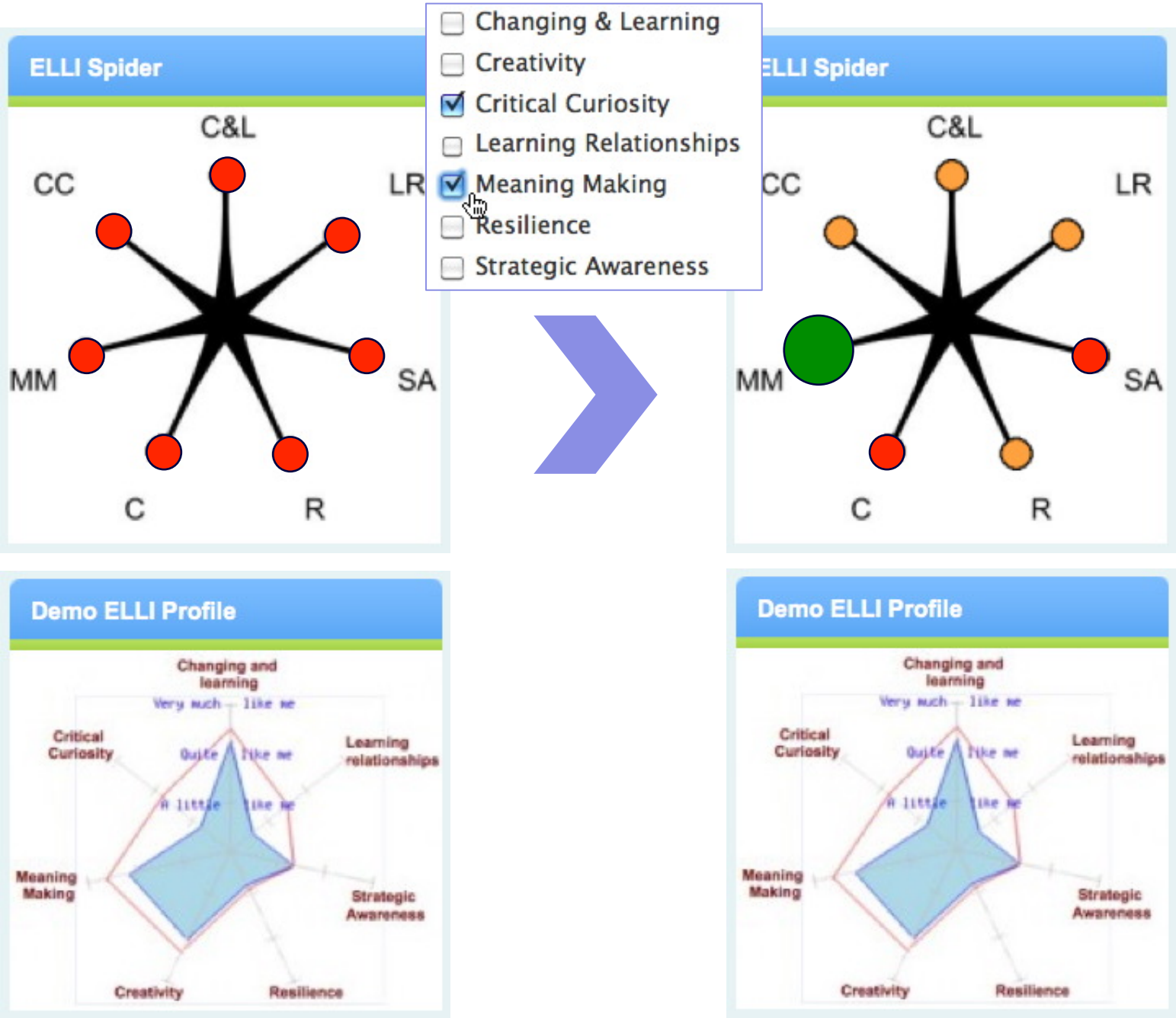
Professional development in schools, colleges and business: ViTaL: http://www.vitalhub.net/vp_research-elli.htm

Analytics tuned to Learning Power: EnquiryBlogger
(National Learning Futures programme: learningfutures.org)

Wordpress multisite plugins tuning it for learning-to-learn dispositions and enquiry skills



http://people.kmi.open.ac.uk/sbs/2011/01/digital-support-for-authentic-enquiry


ELLI Spider
C&L
CC
LR
MM
SA
C
R
Changing & Learning
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Strategic Awareness
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C&L
CC
LR
MM
SA
C
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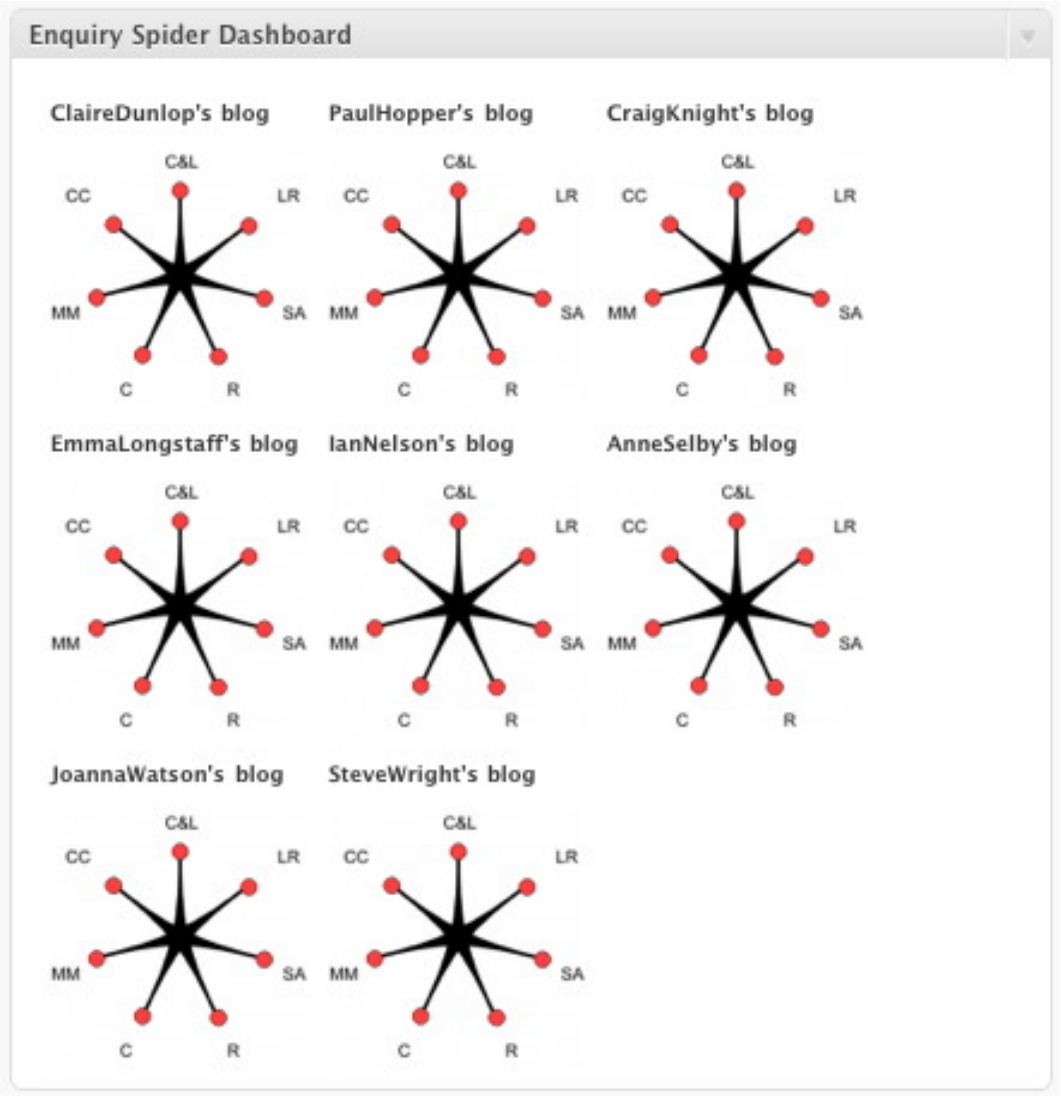
EnquiryBloggers with *teacher* status can view their cohorts plugins in their Dashboard



Example

discourse analytics

Discourse analytics

Effective learning conversations display some typical characteristics which learners can and should be helped to master

“theory-based analytics”

Learners’ written, online conversations can be analysed computationally for patterns signifying weaker and stronger forms of contribution

Socio-cultural discourse analysis
(Mercer et al, OU)

- **Disputational talk**, **characterised by** **disagreement and individualised decision making**.
- **Cumulative talk**, **in which speakers** **build positively but uncritically on what the others have said**.
- **Exploratory talk**, **in which partners** **engage critically but constructively** **with each other's ideas.**

Mercer, N. (2004). Sociocultural discourse analysis: analysing classroom talk as a social mode of thinking. *Journal of Applied Linguistics, 1(2), 137-168.*

Socio-cultural discourse analysis
(Mercer et al, OU)

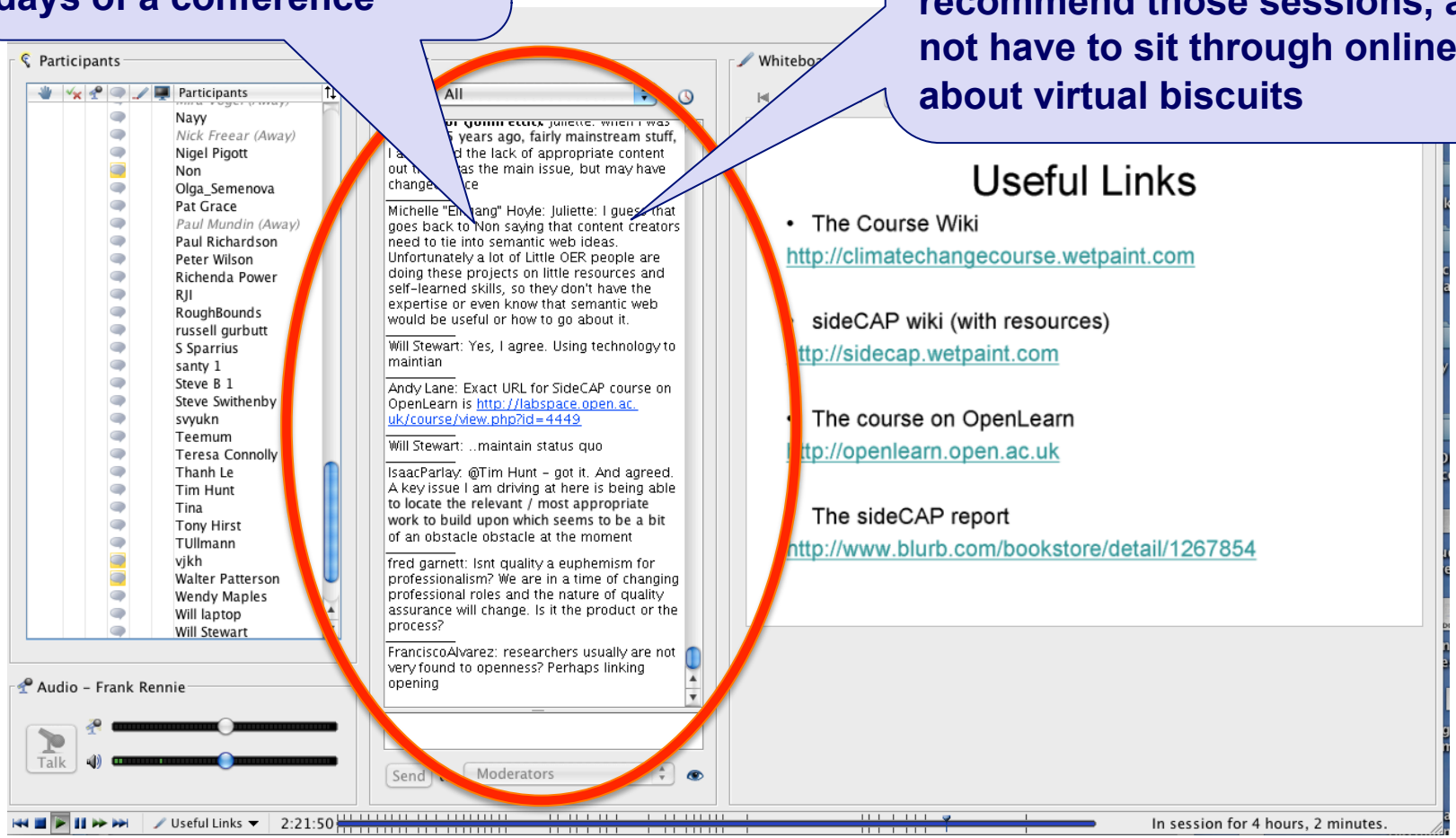
- **Exploratory talk, in which partners engage critically but constructively with each other's ideas.**
  - Statements and suggestions are offered for joint consideration.
  - These may be challenged and counter-challenged, but challenges are justified and alternative hypotheses are offered.
  - Partners all actively participate and opinions are sought and considered before decisions are jointly made.
  - Compared with the other two types, in Exploratory talk knowledge is made more publicly accountable and reasoning is more visible in the talk.

Mercer, N. (2004). Sociocultural discourse analysis: analysing classroom talk as a social mode of thinking. *Journal of Applied Linguistics, 1(2), 137-168.*

Analytics for identifying Exploratory talk

Elluminate sessions can be very long – lasting for hours or even covering days of a conference

It would be useful if we could identify where learning seems to be taking place, so we can recommend those sessions, and not have to sit through online chat about virtual biscuits



Ferguson, R. and Buckingham Shum, S. (2011). Learning Analytics to Identify Exploratory Dialogue within Synchronous Text Chat. *Proc. 1st Int. Conf. Learning Analytics & Knowledge.* Feb. 27-Mar 1, 2011, Banff

Analytics for identifying Exploratory talk

Category	Indicator
Challenge	But if, have to respond, my view
Critique	However, I'm not sure, maybe
Discussion of resources	Have you read, more links
Evaluation	Good example, good point
Explanation	Means that, our goals
Explicit reasoning	Next step, relates to, that's why
Justification	I mean, we learned, we observed
Reflections of perspectives of others	Agree, here is another, makes the point, take your point, your view

Ferguson, R. and Buckingham Shum, S. (2011). Learning Analytics to Identify Exploratory Dialogue within Synchronous Text Chat. *Proc. 1st Int. Conf. Learning Analytics & Knowledge.* Feb. 27-Mar 1, 2011, Banff

Discourse analysis with Xerox Incremental Parser (XIP)

Detection of salient sentences based on rhetorical markers:

BACKGROUND KNOWLEDGE:

Recent studies indicate …

… the previously proposed …

… is universally accepted ...

NOVELTY:

... new insights provide direct evidence ...

... we suggest a new ... approach ...

... results define a novel role ...

OPEN QUESTION:

… little is known …

… role … has been elusive

Current data is insufficient …

CONRASTING IDEAS:

… unorthodox view resolves … paradoxes …

In contrast with previous hypotheses ...

... inconsistent with past findings ...

SIGNIFICANCE:

studies ... have provided important advances

Knowledge ... is crucial for ... understanding

valuable information ... from studies

SUMMARIZING:

The goal of this study ...

Here, we show ...

Altogether, our results ... indicate

GENERALIZING:

... emerging as a promising approach

Our understanding ... has grown exponentially ...

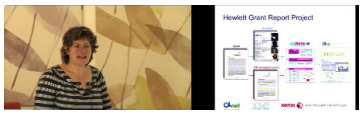
... growing recognition of the importance ...

SURPRISE:

We have recently observed ... surprisingly

We have identified ... unusual

The recent discovery ... suggests intriguing roles



Ágnes Sándor & OLnet Project:
http://olnet.org/node/512

xerox
Xerox Research Centre Europe

Human and machine annotation of literature

The primary goal of this project was to conduct an exploratory research study to determine if providing a professional development program using open education resources (OER) would help teachers begin to transform their curriculum and teaching through the use of technology. Our eight-year Maine Learning Technology Initiative (MLTI) experience had shown us that while providing laptops to all middle school teachers and students has had many positive impacts on schools, classrooms and learning, many mathematics teachers still had not fully integrated the laptop technology into their teaching. Accordingly, this research study was designed to determine the impacts of helping a group of middle school and high school mathematics teachers, through professional development with mathematics OER, to teach targeted algebra topics using technology.

Comment [Pangiota 1]: Brief summary

Comment [Pangiota 2]: summary

Several key activities were undertaken in this project over an 18-month time period. First, we attempted to conduct an environmental scan to determine the challenges teachers encounter in using OER. Although the use of OER has grown quite extensively in higher education and K-12 settings in developing countries, OER use by K-12 teachers in the United States appears to be limited. The purpose of this activity was to explore why this was the case, to identify challenges teachers encounter in using OER, and to develop strategies for overcoming these challenges through our professional development program and research. This environmental scan consisted of several activities, including interviews with leading OER experts and proponents, surveys of teachers, and a limited number of focus groups. Through these activities we began to draw conclusions about the use of OER in K-12 school settings, and these conclusions are discussed below under Lessons Learned.

Comment [Pangiota 3]: good arguments, rigorous methodology

Comment [Pangiota 4]: multiple methods

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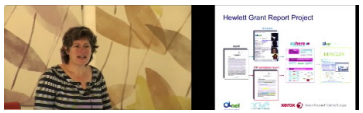
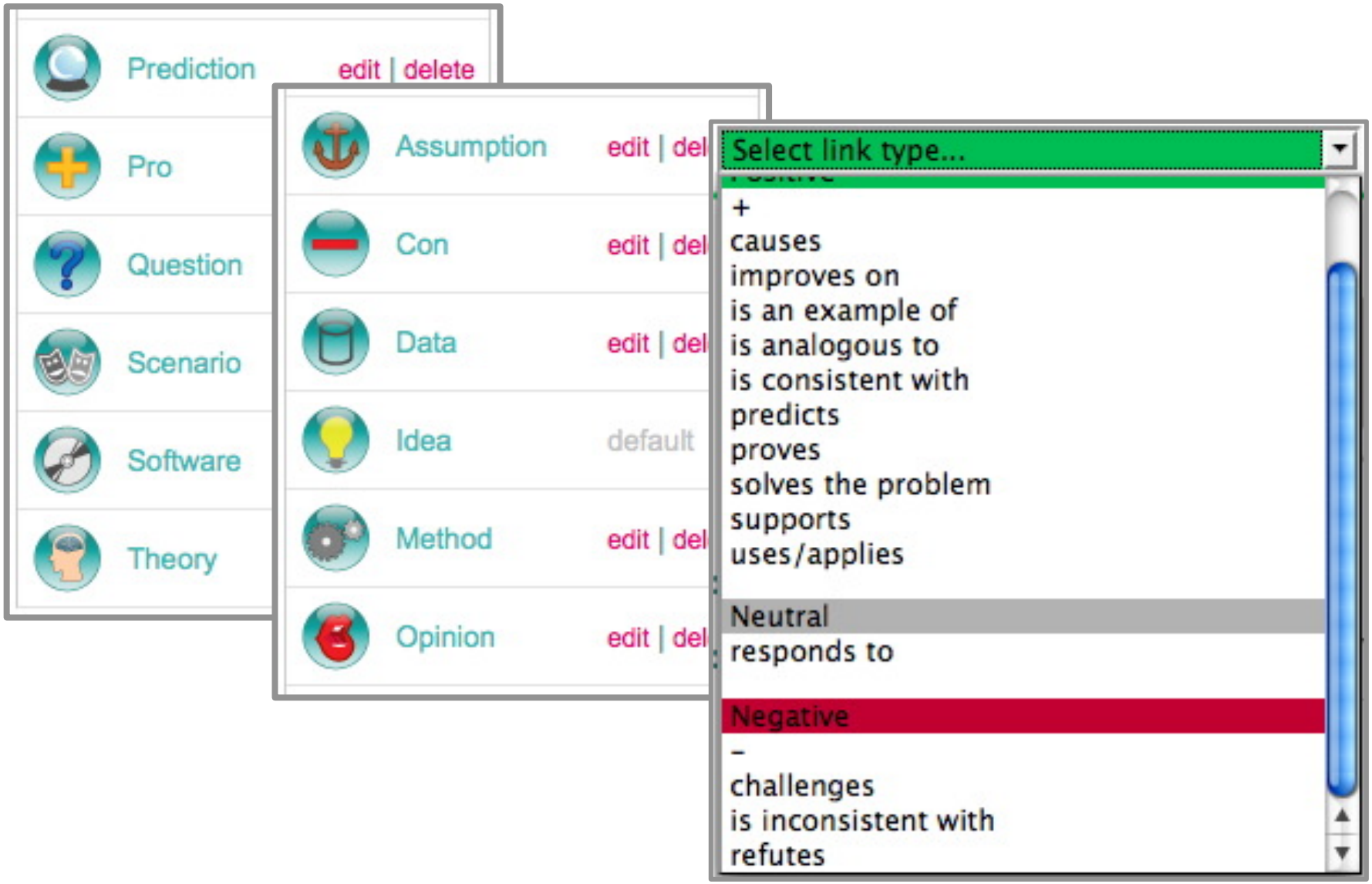
Document 1	**19 sentences annotated**	**22 sentences annotated** **11 sentences = human annotation**
Document 2	**71 sentences annotated**	**59 sentences annotated** **42 sentences = human annotation**



Analyst-defined visual connection language



De Liddo, A. and Buckingham Shum, S. (2011). Discourse-Centric Learning Analytics. *Proc. 1st Int. Conf. Learning Analytics & Knowledge.* Feb. 27-Mar 1, 2011, Banff

cohere — discourse-centric analytics

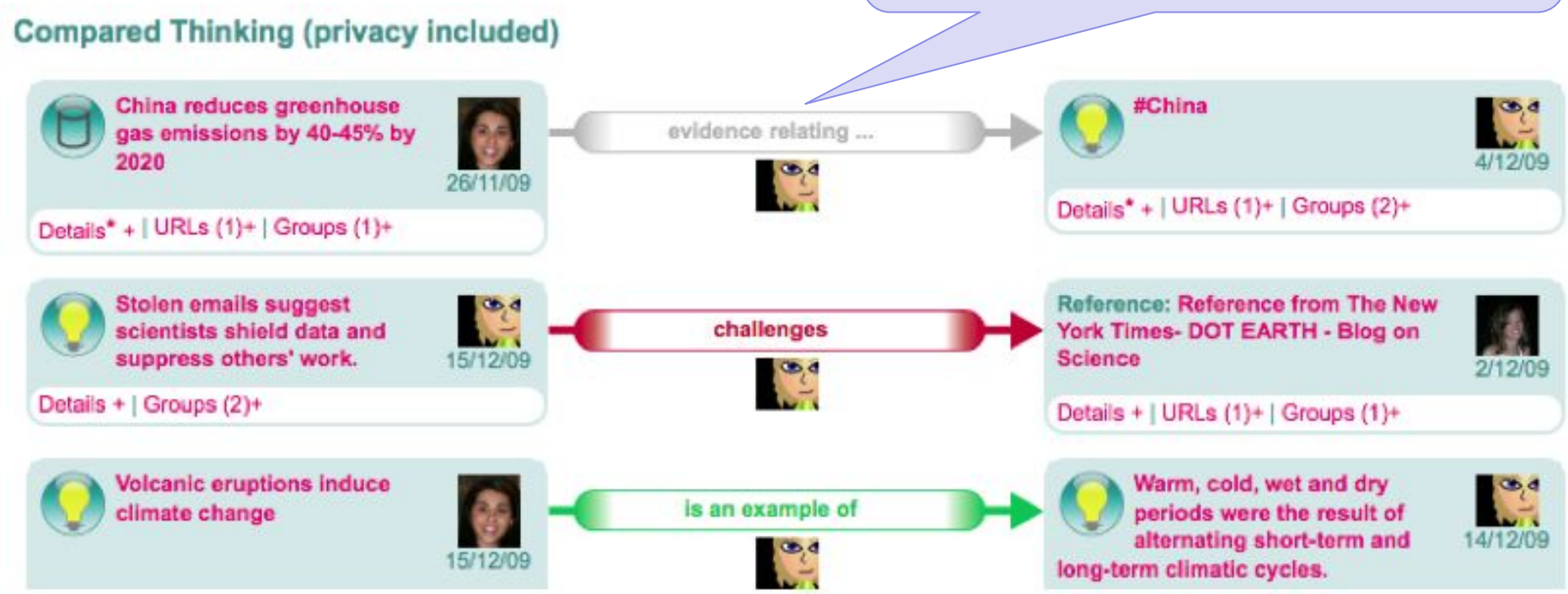
Node Types

Name	Count
Idea	31
Opinion	11
International perspective	9
Action	8
Data	6
Con	4
Utilisation	4
Illustration	3
Response	3
Extension	3
Question	3
Theory	2
Scenario	1
Note	1
Assumption	1

De Liddo, A. and Buckingham Shum, S. (2011). Discourse-Centric Learning Analytics. *Proc. 1st Int. Conf. Learning Analytics & Knowledge.* Feb. 27-Mar 1, 2011, Banff

cohere — discourse-centric analytics

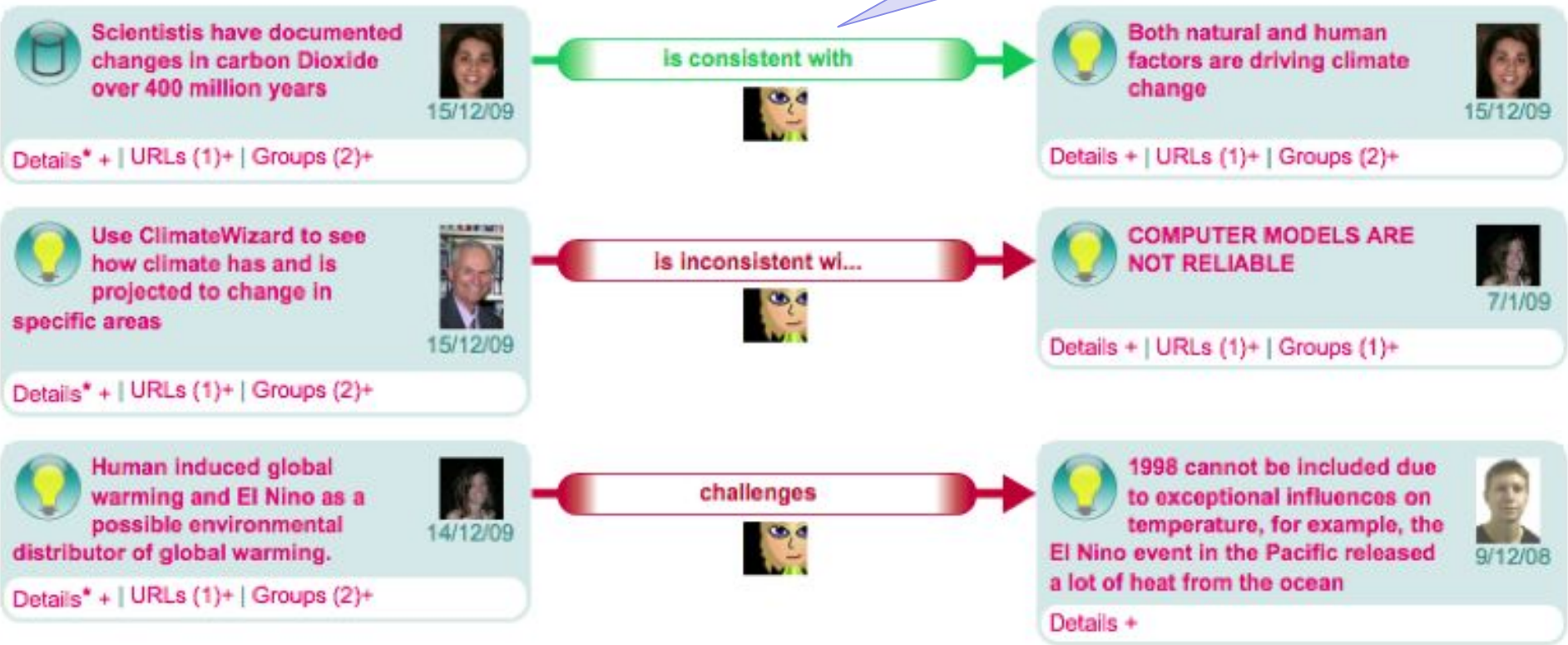
Does the learner compare his/her own ideas to that of peers, and if so, in what ways?



De Liddo, A. and Buckingham Shum, S. (2011). Discourse-Centric Learning Analytics. *Proc. 1st Int. Conf. Learning Analytics & Knowledge.* Feb. 27-Mar 1, 2011, Banff

cohere — discourse-centric analytics

Does the learner act as a broker, connecting the ideas of his/her peers, and if so, in what ways?



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LAK 2015?...

New learning theories have emerged which are dependent on the enabling capabilities of online analytics to provide data on a huge scale…

“theory-based analytics”

While in tandem, new categories of learning analytic and rec-engine have emerged in specific response to the need to test emerging theories with computational models and datasets

Discussion!

?

“theory-based analytics”

?