

# Automated Assessments for Knowledge Creation: A Review of Possibilities

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#### **Motivations**

Embedded and transformative assessment plays an important role in knowledge building (Scardamalia, 2002), by allowing teachers and students to identify advances and problems of understanding as work proceeds, thereby turning greater agency over to participants and engaging them in self assessment of their knowledge advances and innovations. Assessment to help guide knowledge building is usually powered by technical tools, with focus on knowledge-building discourse in Knowledge Forum (Burtis, 1998; Oshima, Oshima, & Matsuzawa, 2012; Teplovs, Donoahue, Scardamalia, & Philip, 2007; van Aalst, Chan, et al., 2012).

The design of next-generation knowledge building environments is faced with a lot of challenges, many of which are related to assessment. For example, to facilitate the process of making synthesis, how could technology help in bringing relevant facts and ideas into discussion and building coherent explanations? How could idea rising be assessed? How to link promising ideas together to help students develop even bigger idea? How to identify "strong" and "weak" social connections in a knowledge-building community and take advantage of both of them by further interventions? Is it possible to automatically tag different ways of contributions by students to enable frequent and spontaneous metadiscourse in knowledge building? These challenges call for introduction of more powerful assessment techniques.

The rise of "learning analytics" as a field of research brings together a substantial base of techniques for analysing discourse (Siemens, 2012). This poster reviews a body of literature relevant to automated assessments, to inform the design and implementation of next-generation assessments for knowledge creation. Reviewed techniques covers innovations from a spectrum of topics, including text mining, semantic analysis, social network analysis, predictive modeling, natural language processing, and information visualization. We wish to apply them creatively and interchangeably to generate new possibilities for automated assessments. Assessments for knowledge creation can then be used by students as well as their teachers to guide their knowledge work.

### Framework of Review

During literature review, we have been continously looking for frameworks to help us bring extensive literature together in a coherent manner. One dimension of this framework of review ought to be related to aspects of knowledge creation that need support from automated assessment. These aspects—such as individual conceptions, improvable ideas, explanatory coherence and social networks—are linked to challenges of knowledge creation discussed above.

Another dimension of our review should inform our evaluation of literature and guide future application of related techniques in assessing knowledge creation. Suthers (2011) proposes a unified framework for multi-level analysis, which facilitates the transition from event data to communication and social network data. This framework is helpful for the study of socio-technical aspect of knowledge creation. However, we worried its focus on network analysis might impede our thinking of broader issues in knowledge creation. Thus, a more general framework could be more appropriate for this literature review task.

Clow (2012) proposes a theoretically-grounded learning analytics model. This model conceptualises successful learning analytics as a cycle involving four steps: **learners** generating **data** that is used to produce **metrics**, **analytics or visualisations**. The key step is "closing the loop" by feeding back results to learners through one or more **interventions**. Its emphasis on feedback and interventions agrees with the notion of transformative and embedded assessment for knowledge creation. It was utilized to guide our review process.

#### References

## A Summary of Possibilities

Aspects	Concept/Technique	Data	Metrics	Interventions
Words, concepts	Apply Catpac <sup>TM</sup> , a neural-based semantic network analysis package, to extract word patterns and clusters (Rosen, Miagkikh, & Suthers, 2011)	Textual data, such as chat log	Co-occurrence between words in a "sliding text window"; connection strengths or weights; word clusters	Use multi-dimensional scaling representation of identified top words to explore contributions from specific users
	Monitor "points of originality" in writing using Wordnet; originality defined as students' ability to place core concepts into new and diffuse usages (Larusson & White, 2012)	Student posts	A specific algorithm for measuring "originality," which basically reflects the presence of linked Wordnet synsets used in one's writing	Key points of originality visualized in a timeline or contextualized manner
Improvable ideas	Assess knowledge level based on Knowledge Indicating Events (KIE) (Kump et al., 2012)	Log data	Algorithms for inferring user knowledge are based on aggregations of all KIE (assumptions involved)	Show a user a treemap visualization of her knowledge levels on various concepts
	Use CarmelTC, a hybrid text classification approach, to assess students' understanding based on their explanations (Rose & VanLehn, 2005)	Student essays	Shallow (i.e. bags of words) approach and deep syntactic analysis	Feed back useful resources that tackle identified missing pieces in student explanations
	Use Latent Semantic Analysis (LSA) to find links between ideas (Teplovs et al., 2011)	KF log data	Cosine similarity between vectors that represents notes	Interactively visualize results in Knowledge Space Visualizer (KSV)
	Apply a (simple) computational technique to discover student science conceptions (Sherin, 2012)	Text-based interview data	A vector space model to represent conceptions; cluster conceptions based on vectors; map clusters with classic conceptions	Visualize changes of conceptions over time during an interview
Explanatory coherence	Use semantically structured annotation to frame discourse, and to allow analysis of rhetorical dimensions of discourse; Cohere (De Liddo et al., 2011)	Dialogues on Cohere	Descriptive statistics of post types; attitude; rhetorical moves; brokerage in networks	Summary of individual or team contribution profiles; sociograms of a team
	Apply Coh-Metrix (a computer tool that scales discourse on measures associated with different discourse levels) to measure text cohesion and difficulty (Graesser & McNamara, 2011)	•	Dozens of measures associated with five discourse levels including surface code, syntax, textbase, situation model, genre and rhetorical composition	N/A
	Use a statistical approach to model dialogue acts in conversational speech (Stolcke et al., 2000)	Conversational speech	Detects and predicts dialogue acts based on lexical, collocational, and prosodic cues, as well as on the discourse coherence of the dialogue act sequence	N/A
Reflection, agency	Track, analyze and reflect on activities (Santos et al., 2012); "Quantified Self"	Rich tracking data from multiple sources	Tracking status of goals; descriptive analysis of activities	A dashboard visualizing a user's progress on multiple goals and activity logs
	Measure "learning dispositions" (or "learning power") with Effective Lifelong Learning Inventory (ELLI) (Buckingham Shum & Crick, 2012)	Data at scale collected from ELLI, a self-diagnostic 'quiz'	Scores on seven dimensions of learning power	Use a spider graph to visualize seven dimensions of learning power to inform learners and stakeholders
Social aspects	Five categories of social analytics, i.e., social network analytics, discourse analytics, content analytics, disposition analytics, and context analytics (Ferguson & Shum, 2012)	Data from SocialLearn	Semantic relations between different learning resources; learning disposition; SNA metrics	Use SNAPP to support both individual and group recommendations; use different dashboards to feed back results to learners
	Modele learning performance with Social Network Analysis (SNA) measures (Paredes & Chung, 2012)	Discussion forum data	A list of SNA metrics, including density, efficiency, Contribution Index, External-Internal Index, Content Richness Score, Average Tie Strength	N/A





