# Online Discourse Analysis in Collaborative Ill-structured Problem Solving for Innovation

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**Abstract:** The quality of online discourse in Computer Supported Collaborative Learning is a vast object of study in recent research in education. Many authors have inspected transcriptions of online discussions with the aim to investigate collaborative knowledge construction via Web. However, there is a necessity to expand ways to evaluate digital discourse in order to better reveal collaborative processes underneath ill-structured problem solving for innovation. In order to have a deeper understanding of the multiple facets of cognitive and interactive processes in online discussion environments, this work proposes a framework to analyze discourse in function of innovation, creativity, and knowledge production contemplating the Hymes' ethnography of communication and John Dewey's philosophy of education.

**Keywords**: Creativity; innovation; computer supported collaborative learning; ill-structured problem-solving, transaction.

## 1. Introduction

Creativity and knowledge advancement are educational objectives that must be inspected in collective meaning making when solving ill-structured problems collaboratively via Web.

Although discourse is not the only way to build knowledge, it is central to the knowledge building process. Collaborative learning is an interactive process, where students acquire communicative abilities and develop mental abilities dialogically, following democratic rules and aiming to solve problems.

In this research, the aim is to approach collaborative knowledge building that emerges from discourse during ill-structured problem-solving aiming innovation. Ill-structured problems can have multiple solutions or methods solving them. They require the learners to acquire knowledge and skills to resolve them. They are generally underspecified, demanding the formulation of multiple hypotheses, and the

search of information with the aim to refine these hypotheses towards a solution. The knowledge is rationally transformed criticized and shared by means of a transformative discourse pursuing original ideas.

Some researchers investigate online discourse in knowledge building via Web (Andrienssen, Baker, and Suthers, 2003; Baker, 2003; Bell, 2004; Khun and Udel, 1997; Teasley, 1997). Such research provides means to analyze information in the virtual discourse, providing convincing clues concerning collaborative learning and knowledge building. However, there is a necessity to expand ways to evaluate digital discourse in order to better reveal collaborative processes underneath ill-structured problem-solving for innovation. In this context, students pursue originality in a situation in which the knowledge is multi-layered, socially negotiated, and continuously subject to re-evaluations. In this sense, the education is for innovation, where solutions are not previously known and there can be more than one correct solution. In order to obtain deeper knowledge, and an innovative solution, students must generate multiple alternative solution paths and reach a consensus about the best solution.

The main objectives in this work are to understand how online discourse triggers the generation of alternative solution paths and the convergence to the best solution and to propose a framework for assessing online argumentation during ill-structured problem-solving for innovation.

## 2. The Study

In this work, Dewey's ideas concerning education are revisited in order to understand the knowledge building process in ill-structured problem solving for innovation. The term transaction emphasizes the transformative aspects of interaction. Dewey (1929), has given a specific name to such a mutual exchange whenever a response to another's act involves contemporaneous response to a thing as entering into other's behavior, and this upon both sides. Based on Dewey´s ideas, it is proposed here a knowledge building cycle with the aim to found theoretically the analysis of collaborative interactions that emerge during ill-structured problem-solving directed to the search of an innovative solution. The cycle that depicts how knowledge evolves is described following:

1.Joint and individual concrete and symbolic experience implies reflections, thinking in action occurs;

2. Reflections cause interpretations and re-interpretations, resuming a transaction;

3. Interpretations and re-interpretations can involve uncertainty or clear interpretations at individual level, as well as, divergence of opinions or intersubjectivity at group level;

4. Both uncertainty and divergence of opinions make continuity in transaction.

In the described knowledge cycle uncertainty or divergence of opinions are crucial for knowledge advancement. Students must engage critically, but creatively with each other' ideas. They must criticize aiming defeat others ideas, and analyze better other ideas to be able to obtain a better idea. On the other hand, when the other student idea is defeated, he is stimulated to enter in a reflexive process too.

The concept of reflection embraces cognitive abilities related to critical, logical and evaluative thinking, and also cognitive processes related to discovery processes. Both convergent thinking and divergent thinking are regarded. Thus, the reflection is seen as a constructive and creative thinking process containing divergent and convergent cognitive activities underlying. The knowledge building cycle makes available a controversial and transactional perspective of how the knowledge advancement occurs during ill-structured problem-solving. Both transactional and controversy aspects are important during the generation of different alternatives, as well as the group convergence to a solution, because stimulate thoughtful consideration of new and creative ideas and avoid a premature movement to consensus.

In productive argumentation, conflicting points of view must arise and be turned in new interpretations. The rationality of the students operates in function of the rationality of other students. Students build knowledge by means of a transactional process that provokes controversy and culminates in a creative synthesis.

## 3. Method

Considering the interconnection between discourse and thinking depicted in the knowledge building cycle, linguistic acts can be seen as social interaction mechanisms building up creative collaborative learning processes. Under this viewpoint, Hymes' socio-linguistic perspective is essential to the comprehension of the transactional subprocesses that comes up at online discussions forums dealing with innovations. Also, the speech act theory and theory of communicative action provides a theoretical based systematic way to evaluate the online messages. A minimal unit of human communication is not a sentence but a performance of a particular kind of language acts, such as assertions, declarations, promises, orders, or requests.

Hymes (1074) called the units in this hierarchy: speech situation or communicative situation, communicative event, and speech act. The speech acts are part of a communicative event and communicative events are part of the speech situation. The speech situation describes the context where the communication is immersed.

## 4. Data analysis

A framework to analyze discourse in function of innovation, creativity, and knowledge production was unveiled from a communicative situation via Web, where qualitatively analyzed asynchronous discussion groups ran during one month. Students in the fourth year of a computer science under-graduate course were expected to formulate an informal graphical user interface specification. The students' interaction processes are performed by means of the discussion forum tool available in the Moodle educational environment. There were 34 students subdivided in groups composed by 3 to 6 students. 205 (two hundred and five) online messages were analyzed.

## 5. Results

Observations of the online discourse unveiled the speech acts and events described in the proposed framework. The inductively derived speech acts reveals reflective thinking and the events uncover transactional processes that emerge during creative collaborative ill-structured problem-solving. The reflexive thinking involves convergent and divergent ways of thinking. It was confirmed the presence of productive online discourse as previously defined in events where the knowledge advanced. Following, the speech acts are being described:

1.Validity checking. Certificating the validity of an argument.
2. Decision. Decision about X or Y is valid. Choosing good criteria or choosing according to criteria.
3. Concept formation. Abstractions made from features and states. Entities correlations.
4. Feature specification. Establishing the properties of an entity.
5. Quantification. Estimative of frequency, percentage, or any other measure of quantity.
6. Definition. Meaning generation.
7. Comparison. Metaphors, analogies and other comparisons according to criteria.
8. Interpretation. Concept or assertive inferred from a static or dynamic data pattern.
9. Deduction. Logical antecedent and consequent. Rules instantiation.
10. Instrumental Action. Production of an action plan or procedure.
11. Information checking. Evaluation of quality and sources of information.
12. Consistency evaluation. Search for contradictions.
13. Redirecting. Reorientation, transformation and conceptual redefinition.
14. Speculation. Search for plausible ideas. Abduction.
15. Relevance analysis. Identification of relevant elements, properties and relationships according to criteria of relevance.
16. Consideration of different points of view. Visualize ideas and objects from different perspectives. Consideration of different contexts.
17. Fluent production. Production of multiple ideas, alternatives and solutions.
18. Original production. Extrapolation.
19. Elaboration. Going deeper into knowledge. Filling with details. Giving more complexity to inter-relationships. Analysis. Synthesis. Criteria establishment.
20. Integrating. Ideas combination and integrating. Synthesis.
21. Convergent organization. Associations. Class membership. To delineate a single path.
22. Divergent organization. Class exclusion. To delineate many paths.

23. Induction. Search for patterns and regularities.
24. Application. Confronting the solution obtained with collected data or personal experiences.
25. Meta-cognition. Reflection concerning the knowledge building process.

The events reflects the transactional features of communication. Following are described the events:

1. Joint Exploration. Joint formulation of new ideas, involving mainly the creative cognitive abilities.
2. Defense. Grounding an opinion. Clearing an misunderstanding or diffuse concept. Sharing information. Defending a previous affirmation based on evidence or posterior interpretation.
3. Attack. Evaluating other's hypothesis or opinion.
4. Advancement. Change of participants positions and arguments advancement. Evidence of evolution and knowledge re-design.
5. Joint comparison. Metaphors and analogies accommodation. Joint analysis of inferred alternatives.
6. Inter-subjectivity. Solution inter-subjectivity, assuring that all participants share the solution.
7. Integration. Integration of important aspects, creating new concepts and pointing out to important or unacknowledged relationships and connections between different perspectives.
8. Rebuttal. Rebuttal is a refutation that results a reinterpretation when confronting a condition capable of defeat or rebut the warrant conclusion.
9. Dialectical Synthesis. Synthesis of the opposing assertions.
10. Systematization. Systematization involves relationships and creation like the integration, but the related action is not only to integrate but also differentiate. The underneath key process is to distinguish or refine relevant concepts.

The data analysis confirmed and refined the productive discussion, unveiling a framework where the rationality of the students operates in function of the rationality of other students. Students build knowledge by means of a transactional process that intertwine the convergent and divergent thinking.

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