Understanding the Paradox of Mental Effort in Online Learning Conversations
Evren Eryilmaz, Jakko Van der Pol, Philip M. Clark, Justin Mary, Terry Ryan
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Motivation

• Why Study Collaborative Knowledge Construction?
  – The central purpose of education is learning to think (Dewey, 1933)
  – Dialogue serves as an instrument for the development of thought (Vygotsky, 1978)
  – Learning occurs when students use dialogue to question, draw inferences, make connections, and validate knowledge about matters of significance (Roschelle, 1992)

• What is the Merit of Asynchronous Online Communication in Collaborative Knowledge Construction?
  – The medium offers opportunities for externalization and internalization of knowledge elements (Lipponen et al., 2001)
  – The process can become more powerful in written form (Pena-Shaff et al., 2004)
  – The medium provides time to be reflective and deliberate (Häkkinen & Järvelä, 2006)

Problem Statement

**Pressing Problem:** The type of interaction necessary for high levels of knowledge construction or truly conversational modes of learning is often lacking in practice (Yang et al., 2008; Janssen et al., 2007)

1. It is difficult to establish and maintain an adequate level of common ground or shared communicative context (Engelmann et al., 2009)

2. The lack of shared contextual cues hinder the identification of cognitive differences that is crucial for the subsequent clarification to bridge the knowledge gap (Ding, 2009)

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Goal & Approach

• **Goal:**
  – Promote rich and constructive interactions in online learning conversations
  – Examine functional characteristics of two forms of artifact-centered discourse systems

• **Approach:**
  – Quasi-experimental design to investigate the aspects of two artifacts design
  – Multi method analysis with fine-grained discourse examination in each system
Effective Inquiry Based Interaction

Constructivist Epistemology:
- “Learning involves active struggling by the learner because knowledge has to be discovered, constructed, practiced, and validated” (Hiltz et al., 2000)

- Social Constructivism: Learning is not only active but also interactive
  - “The social process of developing shared understanding through interaction is the natural way for people to learn” (Hiltz, 1994)
  - Two forms of grounding activities are essential for joint meaning making in social interaction (Baker et al., 1999)
    - Pragmatic Grounding: Establishing and maintaining mutual understanding between conversational participants
    - Semantic Grounding: Effort on constructive interactions after understanding communicative intentions


Effective Inquiry Based Interaction

Cognitive Load Theory:

- Learning outcomes depend largely on the pattern of cognitive load imposed the learner’s working memory by learning material and learning activities (Gerjets and Scheiter, 2003)
- Three guidelines to circumvent constraints of working memory capacity (Van Merriënboer et al., 2002)
  1. Prevent cognitive overload
  2. Minimize extraneous cognitive load
  3. Maximize germane cognitive load within the limits of total cognitive capacity

Effective Inquiry Based Interaction

Inquiry-Based Interaction

Semantic Grounding
- Sharing Conceptual Understanding
- Exploring Differences in Understandings
- Extending Shared Understandings

Pragmatic Grounding
- Establishing Shared Frame of Reference
- Maintaining Discourse Coherence

Variable division of students' mental effort over:

Learning Outcomes
- Deep Understanding Of Academic Text

Generate
Conditions for Effective Inquiry-Based Interaction

• Community of Inquiry: Intentional development of an online learning community to nurture collaborative knowledge construction (Garrison & Arbaugh, 2007)
  – Social Presence: A sense of belonging that helps students actively collaborate
  – Cognitive Presence: Back-and-forth discussion for joint thinking
  – Teaching Presence: Didactical part of the learning process

• Learning Material: Represents the inherent complexity of the learning material being dealt with.
  – Learning Material Difficulty: Natural complexity of the learning material can not be altered by instructional design (Gerjets & Scheiter, 2003)

Conditions for Effective Inquiry-Based Interaction

- Parallel Artifact-Centered Discourse Environment

Epistemology or Pedagogy, That Is the Question

At the time of writing, there is an animated debate which has apparently split the educational world—both teachers and researchers—into two ideological factions. The first faction is depicted as old-school pedagogues who believe that all teaching and instruction should be based upon classical, stage-on-the-stage, arbor-topical and didactic approaches of universal truths. The second faction is depicted as fuzzy-brained social constructivists who believe that nothing is true and that learners can only learn by constructing their own knowledge and behaviors through unstructured experiences. This debate has infiltrated every corner of our discussions on teaching, learning, and education at scientific and professional conferences, in scientific and professional journals, and, in many countries, even the mass media and national politics. Of course we, as rational, right-minded people, know that neither faction is correct and that the “truth” lies in the middle. For this reason, I will try to avoid this ideological discussion and concentrate on a deeper underlying question, namely whether we are selling ourselves and our children short when we use or substitute an epistemology of a domain for a pedagogy for teaching in that domain. Before beginning, I need to define these two terms.
Linked Artifact-Centered Discourse Environment

Conditions for Effective Inquiry-Based Interaction

- Behavioral approaches are anti-educative. (Investigative) Core behaviors, in particular, are highly perspicuous and have their origins in the non-educational, in the belief that behavior is the key to the maintenance of a system. When behavior is understood as a means to an end, it is the goal-directedness of behavior that is emphasized, not the process of inquiry itself. This is because the focus is on the achievement of a particular outcome, not the process by which it is achieved.

- Critical pedagogy focuses on the "learning system" as described by Freire, which is the basis of our current educational system. In this system, critical pedagogy is concerned with the realization of students' potential to participate actively and responsibly in the social and political life of the community. Critical pedagogy is based on the recognition that learning is a social process and that students are active participants in their own learning.

- Foundational Principles

  Critical pedagogy rests on the assumption that education is a means to social change and that schools have a responsibility to prepare students to participate in society. This is because critical pedagogy is concerned with the development of students' critical consciousness, which is the ability to think critically about the social and political structures that shape their lives.

- A unique task of critical pedagogy is to confront and challenge the educational system in order to change it. This is because critical pedagogy is concerned with the development of students' critical consciousness, which is the ability to think critically about the social and political structures that shape their lives. This is achieved by focusing on the development of students' critical consciousness, which is the ability to think critically about the social and political structures that shape their lives.
Research Model and Hypotheses

Inquiry-Based Interaction

Semantic Grounding
- Sharing Conceptual Understanding
- Exploring Differences in Understandings
- Extending Shared Understandings

Pragmatic Grounding
- Establishing Shared Frame of Reference
- Maintaining Discourse Coherence

Variable division of students’ mental effort over:

Community of Inquiry
- Social Presence
- Cognitive Presence
- Teaching Presence

Tool
- Parallel vs. Linked Artifact-Centered Discourse

Task
- Task Difficulty

Generate

Learning Outcomes
- Deep Understanding Of Academic Text

Determine
Research Model and Hypotheses

• **Research Question:** What effect does a linked artifact-centered discourse system have on inquiry-based interaction and learning outcomes?

• **Major Hypothesis:** A properly designed linked artifact-centered discourse system offloads mental effort for establishing a shared frame of reference and maintaining discourse coherence onto the technology, leaving more effort for interactions more productive to learning

  H1: Linked artifact centered discourse environment will decrease establishing shared frame of reference effort
  H2: Linked artifact-centered discourse environment will decrease maintaining discourse coherence effort
  H3: Linked artifact-centered discourse will increase semantic grounding effort
  H4: Higher semantic grounding effort will increase learning outcomes
Research Method

Design: Quasi-experiment with a treatment and control group
Participants: N =122
  – 16 doctoral students for the pilot study
  – 106 pharmacy students for the main study

Methods: Multi-method analysis
  Community of Inquiry: Survey validated by Shea and Bidjerano (2009)
  Learning Material Difficulty: “How difficult was the learning material for you?”
  Establishing Shared Frame of Reference: Developed survey instrument and Van der Pol et al. (2006)’s coding scheme
  Maintaining Discourse Coherence: Developed survey instrument
  Semantic Grounding: Coding scheme developed by Pena-Shaff and Nicholls (2004) and sequential analysis (Jeong, 2003)
  Learning Outcome: Pre- and post-knowledge tests to investigate individual understanding of the learning material before and after peer discourse (see Jamaludín et al., 2009 for the essay scoring rubric)


Key Findings

• Pilot Study Findings: Internal consistency of the survey questions
  – Establishing shared frame of reference items showed a Cronbach's $\alpha$ value of 0.71
  – Maintaining discourse coherence items had a Cronbach's $\alpha$ value of 0.74

• Main Study Findings:
  – Community of Inquiry: No significant differences between the groups ($p > 0.05$)
  – Learning Material Difficulty: No significant difference on perceived learning material difficulty between the treatment group ($M = 3.73$, $SD = 0.69$, $N= 53$) and the control group ($M= 3.81$, $SD = 0.79$, $N= 53$)
Key Findings

• Establishing Shared Frame of Reference Findings:
  – Referencing a message to a certain passage from the article:
    – Accessing a passage from the article by using the reference provided with a message
      • 5 items had internal consistency of 0.80 after refinement
    • Treatment group invested significantly less mental effort for accessing a passage, \( t(104) = -3.17, p < 0.01 \)

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<tr>
<th>Category</th>
<th>Treatment Group</th>
<th>Control Group</th>
</tr>
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<tbody>
<tr>
<td>Comprehensive Referencing to a Location in the Article</td>
<td>0.01</td>
<td>0.14</td>
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<tr>
<td>Demonstrative Referencing to a Location in the Article</td>
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<td>0.03</td>
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Key Findings

• Maintaining Discourse Coherence Findings:
  – 5 items had internal consistency of 0.84 after refinement
  – Treatment group invested significantly less mental effort for maintaining discourse coherence, $t(104) = -3.17, p < 0.01$

• Semantic Grounding Findings:

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<th>Category</th>
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<th>Control Group</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Proportion</td>
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<td>Question</td>
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<td>0.16</td>
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<tr>
<td>Clarification</td>
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<td>0.02</td>
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<tr>
<td>Interpretation</td>
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<td>0.45</td>
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<td>Conflict</td>
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<td>0.08</td>
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<tr>
<td>Consensus Building</td>
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<td>0.11</td>
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<tr>
<td>Assertion</td>
<td>70</td>
<td>0.14</td>
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<tr>
<td>Support</td>
<td>19</td>
<td>0.04</td>
</tr>
<tr>
<td>Total</td>
<td>499</td>
<td>100%</td>
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Key Findings

- Semantic Grounding Findings:

Transitional State Diagram for Treatment Group
Key Findings

• Semantic Grounding Findings:

Transitional State Diagram for Control Group
Key Findings

- Learning Outcome Findings:

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<thead>
<tr>
<th>Groups</th>
<th>Pre-Test (n =53)</th>
<th>Post-Test (n =53)</th>
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<tbody>
<tr>
<td>Control</td>
<td>M = 5.71, SD = 1.46</td>
<td>M = 7.26, SD = 1.36</td>
</tr>
<tr>
<td>Treatment</td>
<td>M = 5.66, SD = 1.36</td>
<td>M = 7.89, SD = 1.31</td>
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Conclusion

• Collaborative situations require the coordination and regulation of the social interaction process itself.
• Linking functionality in an artifact-centered discourse environment facilitates pragmatic grounding activities to attain a common ground
• Less need to attain an adequate level of common ground through pragmatic grounding activities leaves more room for semantic grounding activities
• More semantic grounding activities lead to a deeper understanding of the learning material
Implications for Instruction

• Setting up an artifact as the topic of an asynchronous discussion may set students’ collaborative intentions towards constructing the meaning of a text
• Parallel artifact-centered discourse system may typically be useful for a sustained, general, and on-topic discussion
• Linked artifact-centered discourse system provided a worthy solution to the issue of attaining common ground in online learning conversations
  – (see www.annotationtool.com/)

• Future Research: Re-design and evaluation of the linked-artifact centered discourse system
Thank You for Your Time

Your Comments and Questions are welcomed

Please address feedback to:

evren.eryilmaz@cgu.edu