Understanding the Paradox of Mental Effort in Online Learning Conversations

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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)

Dewey, J. (1933). How we think. New York: Prometheus Books

Vygotsky, L.S. (1978). *Mind in society*. Cambridge MA: Harvard

Roschelle, J. (1992). Learning by collaborating: Convergent conceptual change. Journal of the Learning Sciences, 2, 235-297.

Lipponen, L.,Rahikainen, M., Lallimo, J., and Hakkarainen, K, (2003). Patterns of participation and discourse in elementary students' computer-supported collaborative learning." *Learning and instruction* 13(5): 487-509.

Pena-Shaff, J. and C. Nicholls (2004). Analyzing student interactions and meaning construction in computer bulletin board discussions. *Computers & Education* 42(3): 243-265.

Häkkinen, P. and Järvelä, S. (2006). Sharing and constructing perspectives in web-based conferencing. *Computers & Education* 47(4): 433-447.

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)

Yang, Y., Newby, T., and Robert, B. (2008). Facilitating interactions through structured web-based bulletin boards: A quasi-experimental study on promoting learners' critical thinking skills. *Computers & Education* 50(4): 1572-1585.

Janssen, J., Erkens, G., and Kanselaar, G. (2007). Visualization of agreement and discussion processes during computer-supported collaborative learning. *Computers in Human Behavior* 23(3): 1105-1125.

Engelmann, T., Dehler, J., Bodemer, D., and Buder, J. (2009). Knowledge awareness in CSCL: A psychological perspective. *Computers in Human Behavior* 25(4), pp. 949-960.

Ding, N. (2009). Visualizing the sequential process of knowledge elaboration in computer-supported collaborative problem solving. Computers & Education 52(2): 509-519.

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

Hiltz, S. R., Coppola, N., Rotter, N., and Turoff, M. (2000) Measuring the importance of collaborative learning for the effectiveness of ALN: a multi-measure, multi-method approach. *Journal of Asynchronous Learning Networks,* 4(2): 103-125.

Hiltz, S. R. (1994). The virtual classroom: learning without limits via computer networks. Norwood, NJ USA: Ablex Publishing Corporation

Baker, M., Hansen, T., Joiner, R., and Traum, D. (1999). The role of grounding in collaborative learning tasks. In P. Dillenbourg (Ed.): *Collaborative learning: Cognitive and computational approaches*. Elseiver Science Publishers: 31-63.

Effective Inquiry Based Interaction

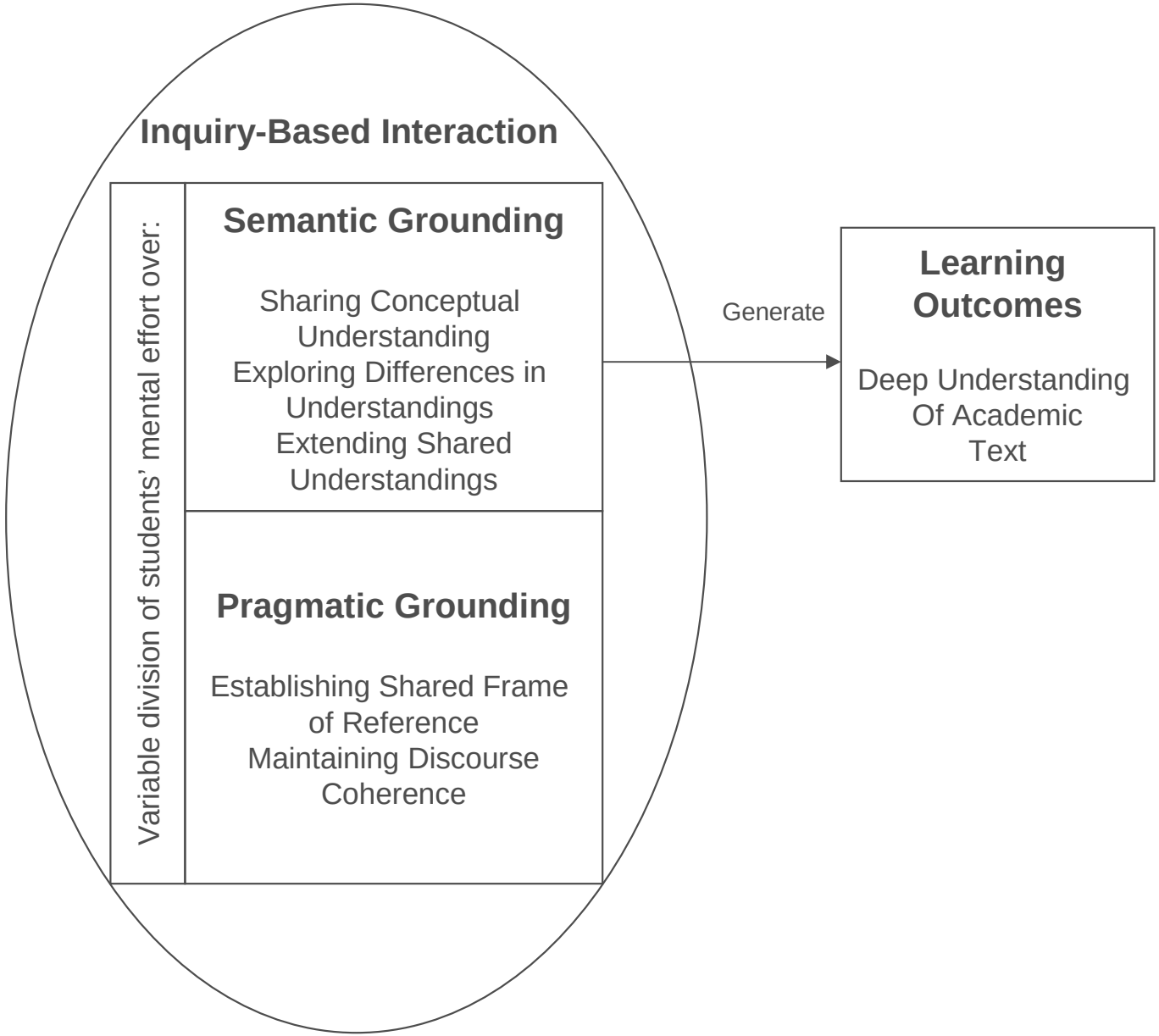
Cognitive Load Theory:

- 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

Gerjets, P. and Scheiter, K. (2003). Goal configurations and processing strategies as moderators between instructional design and cognitive load: Evidence from hypertext-based instruction. Educational Psychologist 38(1): 33-41.

Van Merriënboer , J. J. G., Schuurman, J. G., de Croock, M. B. M., & Paas, F. (2002).Redirecting learners' attention during training: Effects on cognitive load, transfer test performance and training efficiency. *Learning and Instruction*, *12*, 11-37.

Effective Inquiry Based Interaction



Conditions for Effective Inquiry-Based Interaction

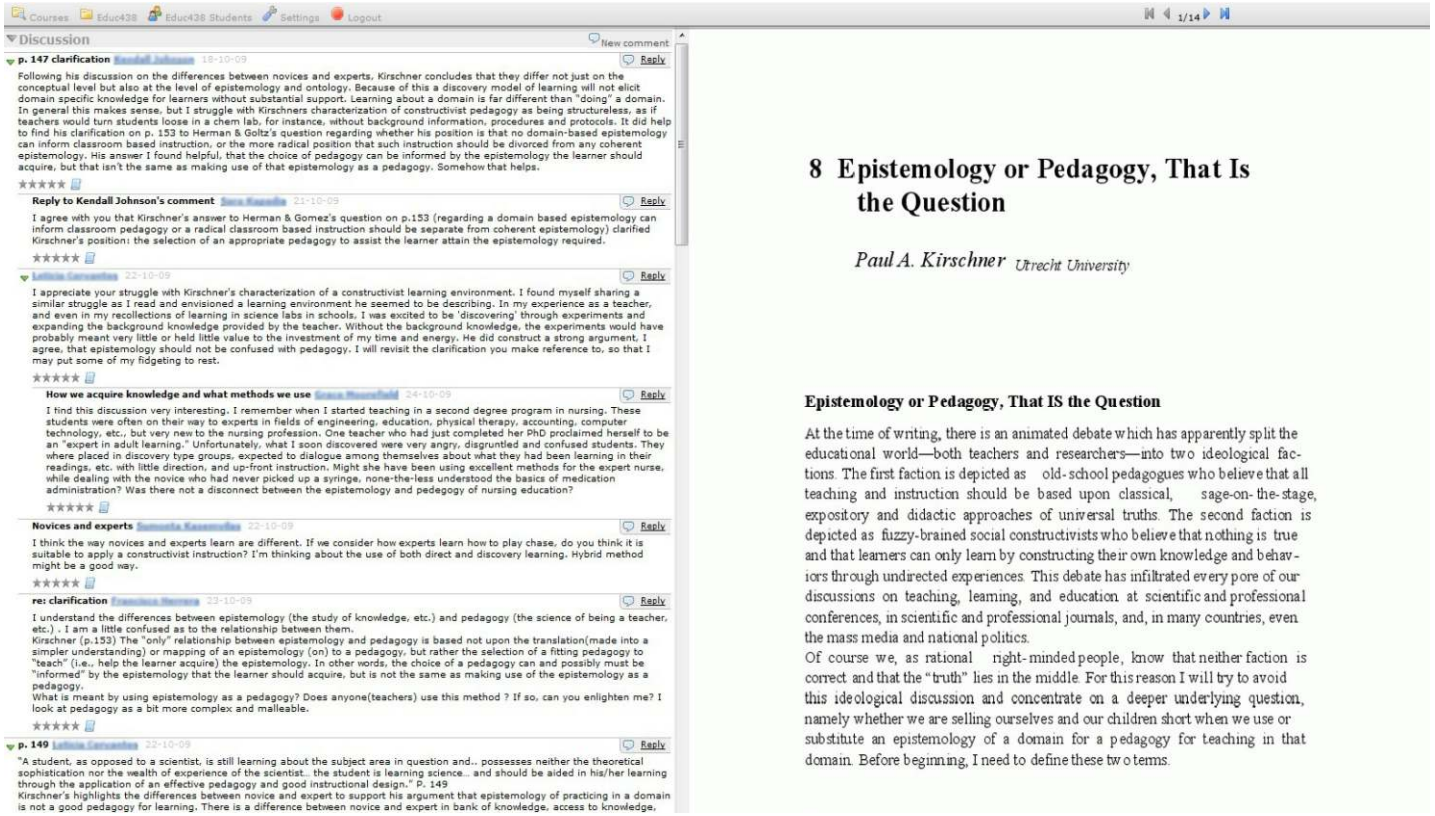
- Community of Inquiry: Intentional development of an online learning community to nurture collaborative knowledge construction (Garrison & Arbaugh, 2007)
  - Social Presence: A sense of belonging that helps students actively collaborate
  - Cognitive Presence: Back-and-forth discussion for joint thinking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

Garrison, D.R., & Arbaugh, J.B. "Researching the Community of Inquiry Framework: Review, Issues and Future Directions," *The Internet and Higher Education* (10:3), 2007, pp. 157-172.

Gerjets, P. and Scheiter, K. (2003). Goal configurations and processing strategies as moderators between instructional design and cognitive load: Evidence from hypertext-based instruction. Educational Psychologist 38(1): 33-41.

Conditions for Effective Inquiry-Based Interaction

- Parallel Artifact-Centered Discourse Environment



Courses Educ438 Educ438 Students Settings Logout

Discussion

New comment

p. 147 clarification Kendall Johnson 18-10-09 — Reply

Following his discussion on the differences between novices and experts, Kirschner concludes that they differ not just on the conceptual level but also at the level of epistemology and ontology. Because of this a discovery model of learning will not elicit domain specific knowledge for learners without substantial support. Learning about a domain is far different than "doing" a domain. In general this makes sense, but I struggle with Kirschners characterization of constructivist pedagogy as being structureless, as if teachers would turn students loose in a chem lab, for instance, without background information, procedures and protocols. It did help to find his clarification on p. 153 to Herman & Goltz's question regarding whether his position is that no domain-based epistemology can inform classroom based instruction, or the more radical position that such instruction should be divorced from any coherent epistemology. His answer I found helpful, that the choice of pedagogy can be informed by the epistemology the learner should acquire, but that isn't the same as making use of that epistemology as a pedagogy. Somehow that helps.

★★★★★

Reply to Kendall Johnson's comment Sara Kapadia 21-10-09 — Reply

I agree with you that Kirschner's answer to Herman & Gomez's question on p.153 (regarding a domain based epistemology can inform classroom pedagogy or a radical classroom based instruction should be separate from coherent epistemology) clarified Kirschner's position: the selection of an appropriate pedagogy to assist the learner attain the epistemology required.

★★★★★

Leticia Cervantes 22-10-09 — Reply

I appreciate your struggle with Kirschner's characterization of a constructivist learning environment. I found myself sharing a similar struggle as I read and envisioned a learning environment he seemed to be describing. In my experience as a teacher, and even in my recollections of learning in science labs in schools, I was excited to be 'discovering' through experiments and expanding the background knowledge provided by the teacher. Without the background knowledge, the experiments would have probably meant very little or held little value to the investment of my time and energy. He did construct a strong argument, I agree, that epistemology should not be confused with pedagogy. I will revisit the clarification you make reference to, so that I may put some of my fidgeting to rest.

★★★★★

How we acquire knowledge and what methods we use Grace Mountfield 24-10-09 — Reply

I find this discussion very interesting. I remember when I started teaching in a second degree program in nursing. These students were often on their way to experts in fields of engineering, education, physical therapy, accounting, computer technology, etc., but very new to the nursing profession. One teacher who had just completed her PhD proclaimed herself to be an "expert in adult learning." Unfortunately, what I soon discovered were very angry, disgruntled and confused students. They where placed in discovery type groups, expected to dialogue among themselves about what they had been learning in their readings, etc. with little direction, and up-front instruction. Might she have been using excellent methods for the expert nurse, while dealing with the novice who had never picked up a syringe, none-the-less understood the basics of medication administration? Was there not a disconnect between the epistemology and pedegogy of nursing education?

★★★★★

Novices and experts Sumuela Kazenzakis 22-10-09 — Reply

I think the way novices and experts learn are different. If we consider how experts learn how to play chase, do you think it is suitable to apply a constructivist instruction? I'm thinking about the use of both direct and discovery learning. Hybrid method might be a good way.

★★★★★

re: clarification Francisco Herrera 23-10-09 — Reply

I understand the differences between epistemology (the study of knowledge, etc.) and pedagogy (the science of being a teacher, etc.) . I am a little confused as to the relationship between them.
Kirschner (p.153) The "only" relationship between epistemology and pedagogy is based not upon the translation(made into a simpler understanding) or mapping of an epistemology (on) to a pedagogy, but rather the selection of a fitting pedagogy to "teach" (i.e., help the learner acquire) the epistemology. In other words, the choice of a pedagogy can and possibly must be "informed" by the epistemology that the learner should acquire, but is not the same as making use of the epistemology as a pedagogy.
What is meant by using epistemology as a pedagogy? Does anyone(teachers) use this method ? If so, can you enlighten me? I look at pedagogy as a bit more complex and malleable.

★★★★★

p. 149 Leticia Cervantes 22-10-09 — Reply

"A student, as opposed to a scientist, is still learning about the subject area in question and... possesses neither the theoretical sophistication nor the wealth of experience of the scientist... the student is learning science... and should be aided in his/her learning through the application of an effective pedagogy and good instructional design." P. 149
Kirschner's highlights the differences between novice and expert to support his argument that epistemology of practicing in a domain is not a good pedagogy for learning. There is a difference between novice and expert in bank of knowledge, access to knowledge,

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8 Epistemology or Pedagogy, That Is the Question

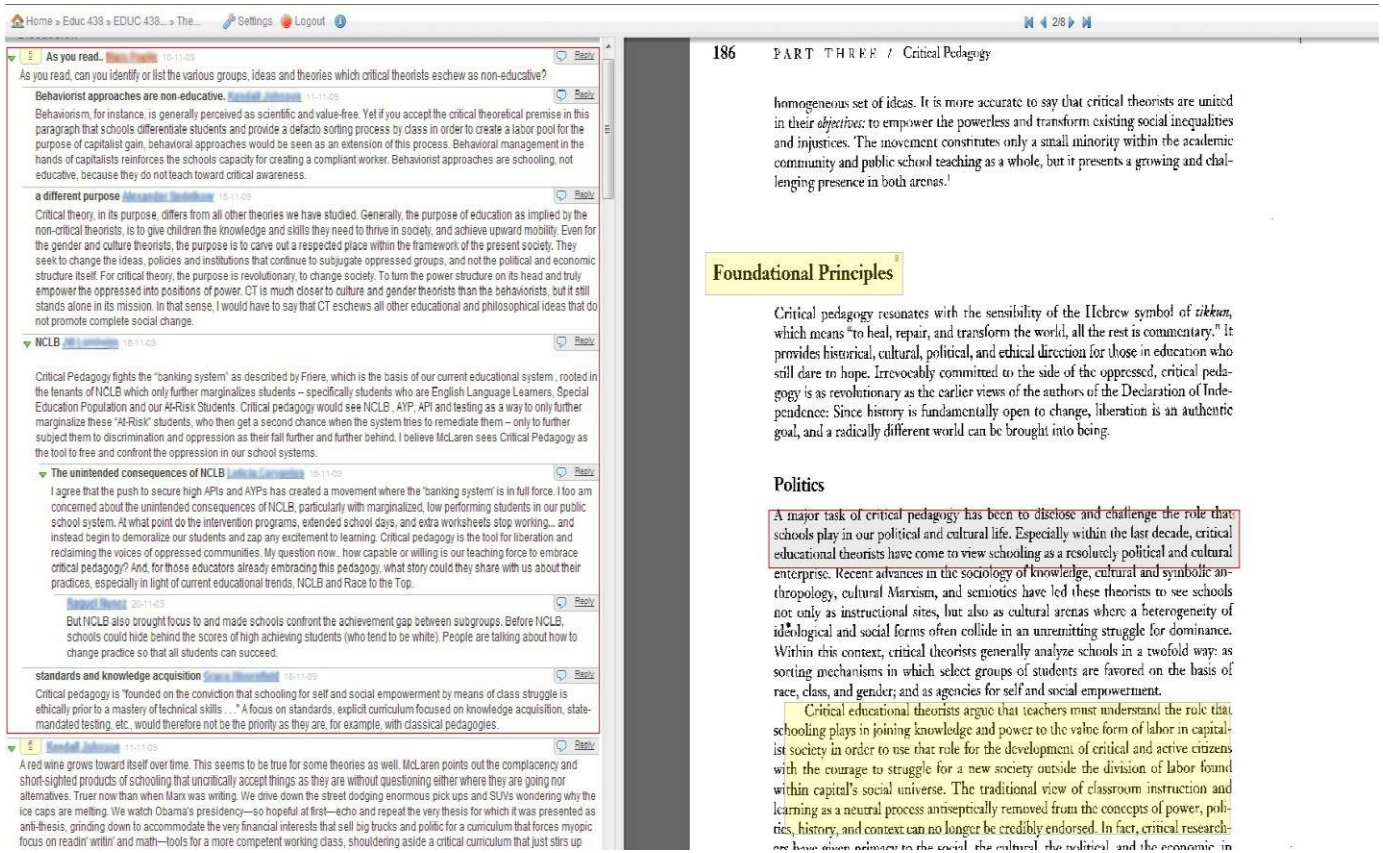
Paul A. Kirschner Utrecht University

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, sage-on-the-stage, expository 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 undirected experiences. This debate has infiltrated every pore 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.

Conditions for Effective Inquiry-Based Interaction

- Linked Artifact-Centered Discourse Environment



(see www.annotationtool.com/)

Research Model and Hypotheses

Community of Inquiry

Social Presence
Cognitive Presence
Teaching Presence

Tool

Parallel vs. Linked Artifact-Centered Discourse

Task

Task Difficulty

Determine

Inquiry-Based Interaction

Variable division of students' mental effort over:

Semantic Grounding

Sharing Conceptual Understanding
Exploring Differences in Understandings
Extending Shared Understandings

Pragmatic Grounding

Establishing Shared Frame of Reference
Maintaining Discourse Coherence

Generate

Learning Outcomes

Deep Understanding Of Academic Text

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 Jamaludin et al., 2009 for the essay scoring rubric)

Van der Pol, J., Admiraal, W., & Simons, P. R. J. (2006). The affordance of anchored discussion for the collaborative processing of academic texts. *International Journal of Computer-Supported Collaborative Learning, 1*(3), 339-357.

Pena-Shaff, J. and Nicholls, C. (2004). Analyzing student interactions and meaning construction in computer bulletin board discussions. *Computers & Education* 42(3): 243-265.

Jeong, A. C. (2003). The Sequential Analysis of Group Interaction and Critical Thinking in Online. *The American Journal of Distance Education, 17*(1), 25-43.

Shea, P. and T. Bidjerano (2009). Community of inquiry as a theoretical framework to foster epistemic engagement and cognitive presence in online education. *Computers & Education* 52(3): 543-553.

Jamaludin, A., Chee, Y., Mei Lin Ho, C. (2009). Fostering argumentative knowledge construction through enactive role play in Second Life. *Computers & Education* 53(2): 317- 329.

Key Findings

- Pilot Study Findings: Internal consistency of the survey questions
  - Establishing shared frame of reference items showed a Cronbach's α value of 0.71
  - Maintaining discourse coherence items had a Cronbach's α 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:

	Treatment Group	Control Group
Category	Proportion	Proportion
Comprehensive Referencing to a Location in the Article	0.01	0.14
Demonstrative Referencing to a Location in the Article	0.12	0.03

  - 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, $t\ (104) = -3.17,\ p < 0.01$

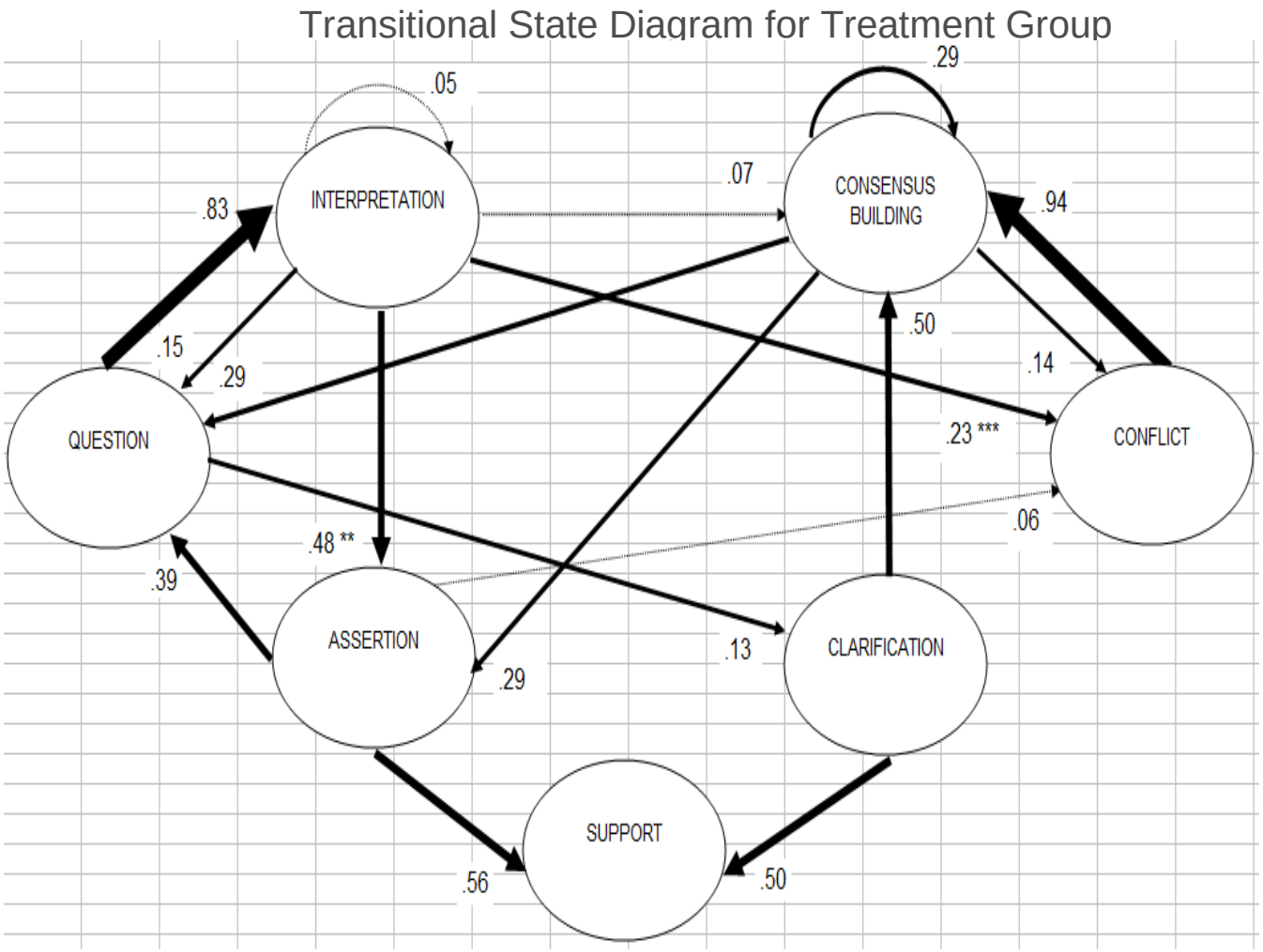
Key Findings

- 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:

	Treatment Group		Control Group	
Category	Number	Proportion	Number	Proportion
Question	82	0.16	77	0.16
Clarification	9	0.02	36	0.07
Interpretation	223	0.45	227	0.46
Conflict	39	0.08	12	0.02
Consensus Building	57	0.11	69	0.14
Assertion	70	0.14	35	0.07
Support	19	0.04	40	0.08
Total	**499**	**100%**	**496**	**100%**

Key Findings

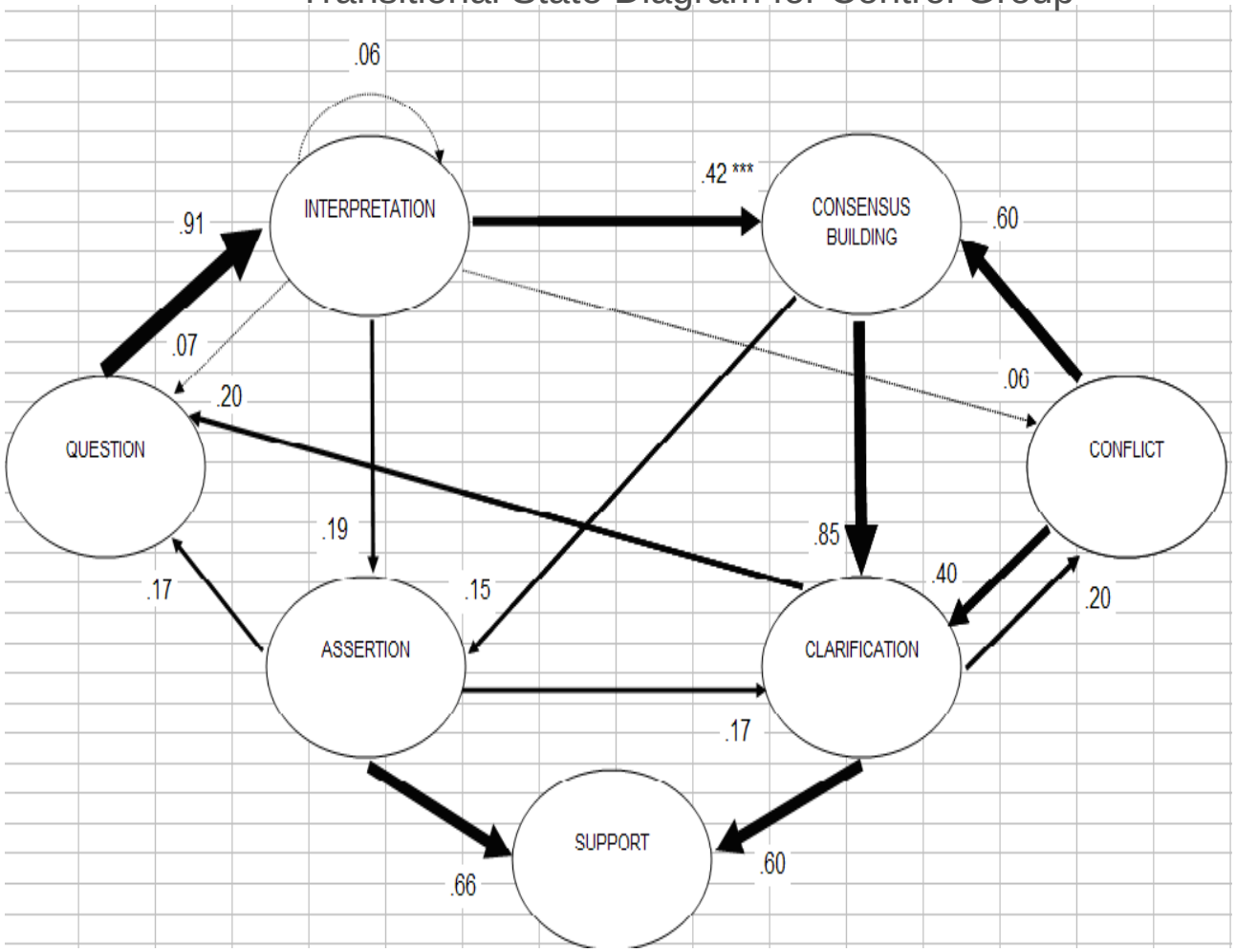
- Semantic Grounding Findings:



Key Findings

- Semantic Grounding Findings:

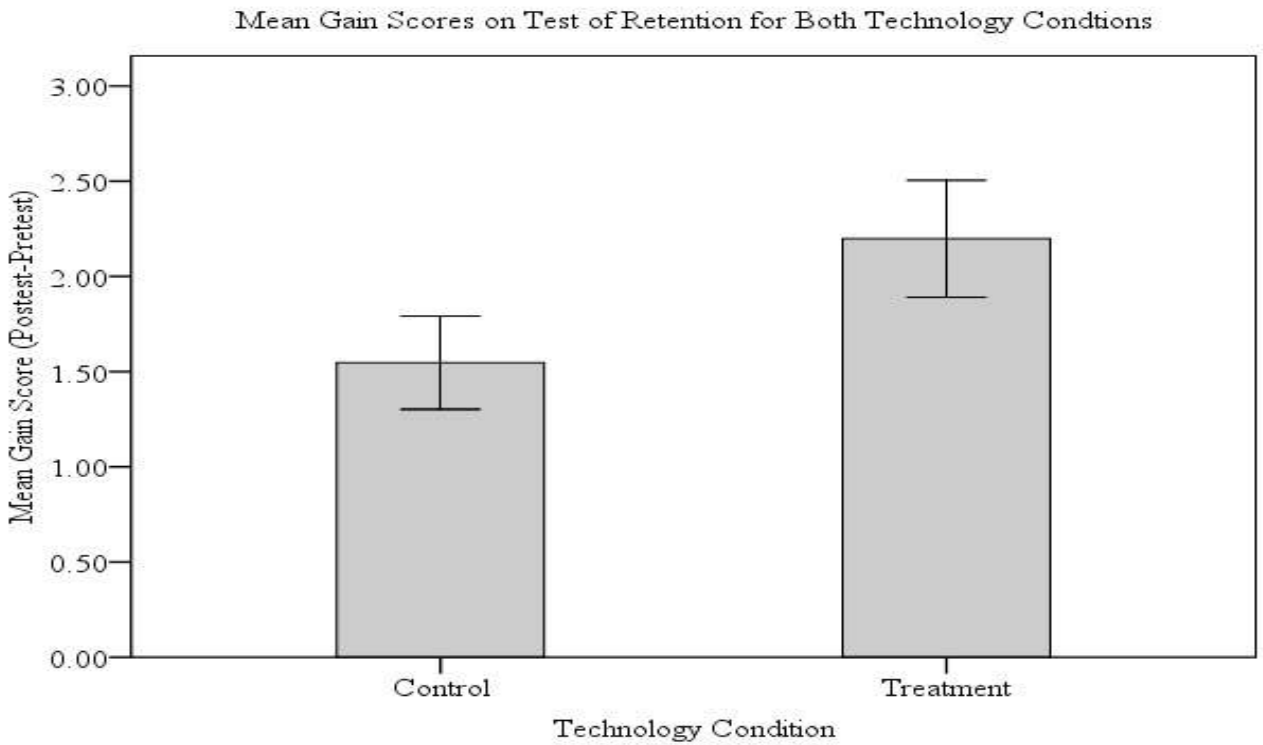
Transitional State Diagram for Control Group



Key Findings

- Learning Outcome Findings:

Groups:	Pre-Test (n =53)	Post-Test (n =53)
Control	M = 5.71, SD = 1.46	M = 7.26, SD = 1.36
Treatment	M = 5.66, SD = 1.36	M = 7.89, SD = 1.31



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:

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