A Design Science Research Methodology for Developing an Open Source Computer Supported Collaborative Learning System

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Agenda

- What is collaborative learning?
  - **Range of views**
  - **Knowledge sharing vs. construction**
  - **Social interaction**
  - **Common Ground**
  - **Socio-cultural perspective**
  - **The interplay among perspective**
- How can technology support collaborative learning?
  - **Fundamental constructs**
  - **Design science research methodology**
  - **General model**
  - **Application of design science guidelines**
- Comments & Questions

What is Collaborative Learning?

- Collaborative learning takes on a great variety of forms along a spectrum from individual to group
  - **Learning is fundamentally a creative cognitive process within an individual's mind, yet this process can be enhanced in settings of collaboration (Eryilmaz et al., 2013)**

Knowledge Sharing vs. Construction

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

Three basic elements:

- Selecting relevant information,
- Organizing it into a coherent representation,
- Integrating it with existing knowledge (Mayer 1999)

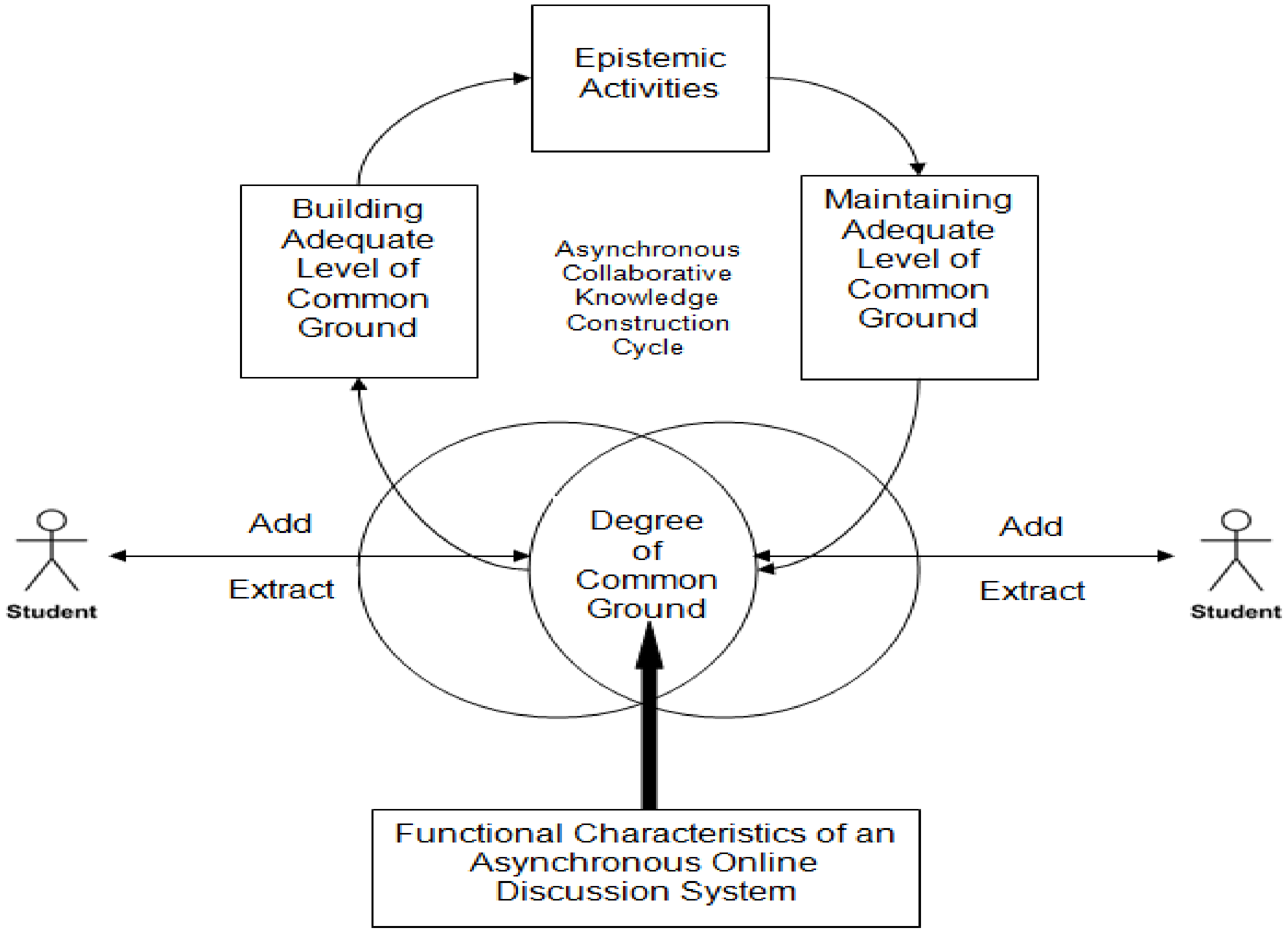
Social Interaction

- A key to successful collaborative learning is social interaction
- Interaction can be defined as a reciprocal event that requires at least two objects and two actions (Wagner, 1994)
- Establishing and maintaining an adequate level of "**common ground**" is a pressing problem in online discussions

Difficult Common Ground Based Questions

- How are students' communication activities affected by the degree of common ground facilitated by the functional characteristics of an asynchronous online discussion system?
- How is common ground built and maintained in ways mediated by the functional characteristics of an asynchronous online discussion system?

Common Ground



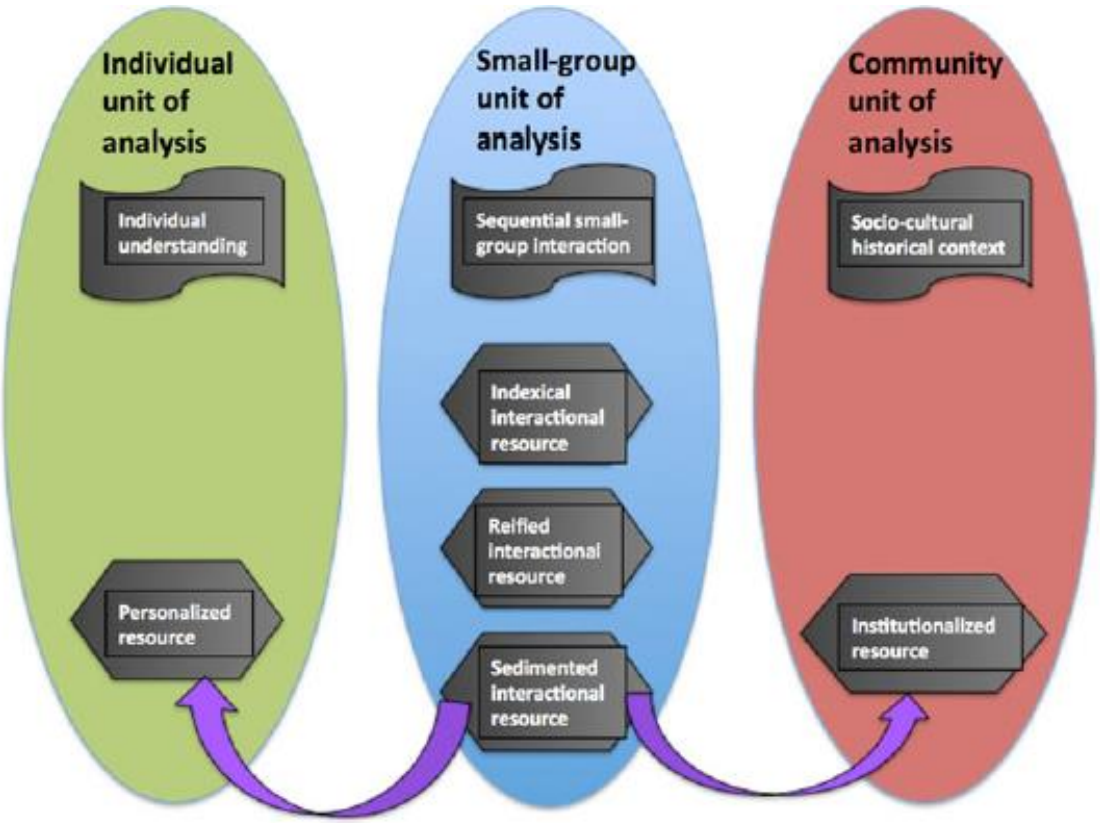
Eryilmaz, E., Ryan, T., Van der Pol, J., Kasemvilas, S., & Mary, J. (2013). Fostering quality and flow of online learning conversations by artifact-centered discourse systems. Journal of the Association for Information Systems, 14(1), 22-48.

Another Perspective on Collaborative Learning

- Socio-cultural perspective: Learning always arises as a product of a social community of practice where people are involved in different types of processes to create meaning.
- Meaning is intersubjective (Suthers, 2006).
- Learning not only accomplished through the interactions of the participants, but consists of those interactions (Koschmann et al., 2005)

The Interplay Among Perspectives

- Learning is a mix of individual and group processes (Stahl, 2013)



How can technology support collaborative learning?

Two fundamental constructs

- Affordances: potentials for action in relation to the actor (Gibson, 1977), of which salient affordances are expected to be the most relevant (Norman, 1999).
- Constraints: complement affordances by indicating the limitations of user actions

Research Methodology

- Design Science Research: Creation of an innovative IT artifact yielding utility for a specific problem domain (Hevnar et al., 2004).
- IT Artifact: Any hardware/software design encapsulating structures, routines, norms, and values implicit in the rich contexts within which the artifact is embedded (Benbasat and Zmud, 2003).

General Model

Follows six steps described by Peffers et al. (2008)

- Step 1: Identify problem
- Step 2: Define solution objectives
- Step 3: Design and development

General Model

- Step 4: Demonstration

- Step 5: Evaluation

- Step 6: Communication

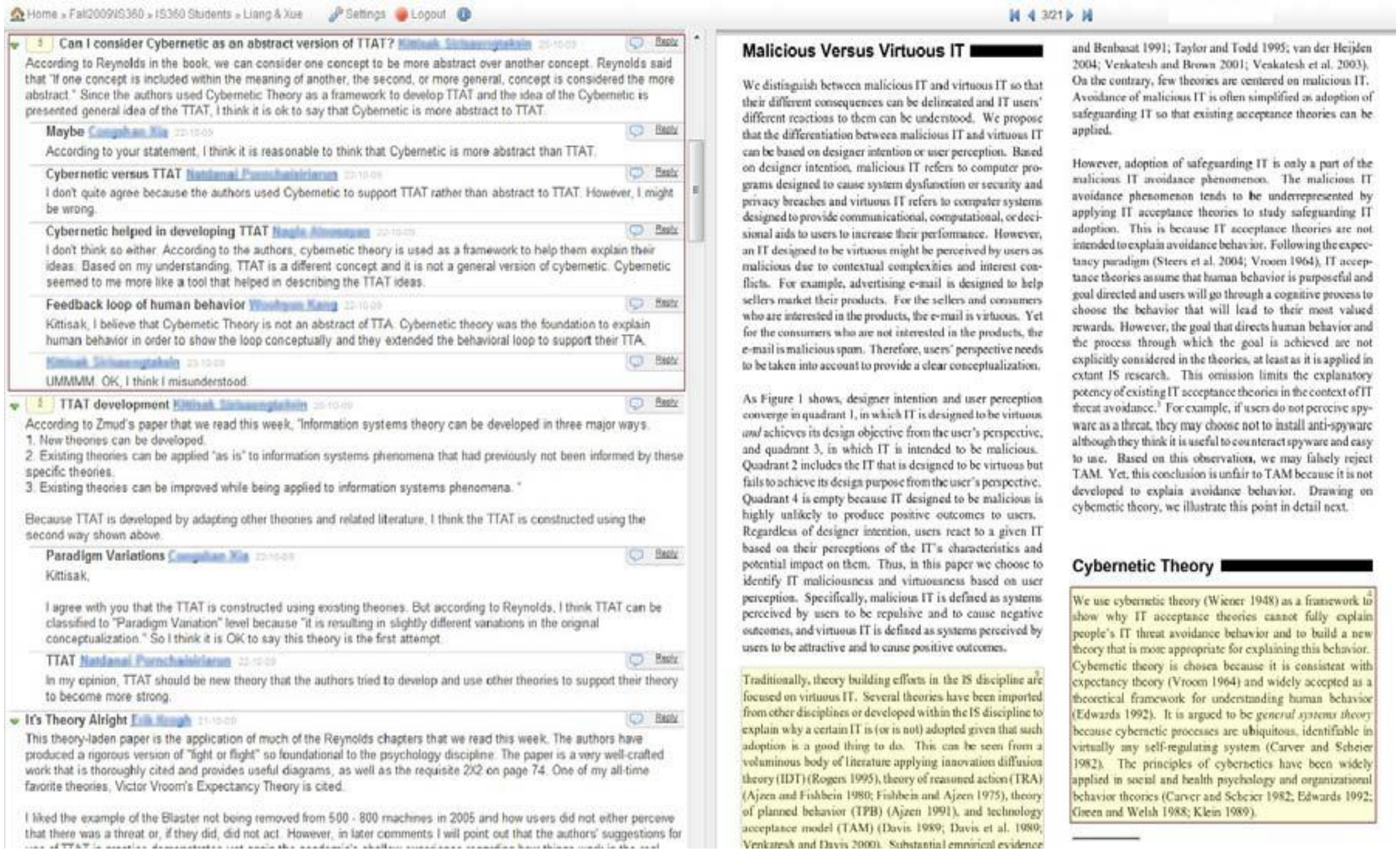
Application of Design Science Guidelines

- Step 1: Problem Identification and Motivation
  - **High levels of knowledge construction is difficult to achieve**
  - **Establishing and maintaining an adequate level of common is a pressing problem in online discussions!**

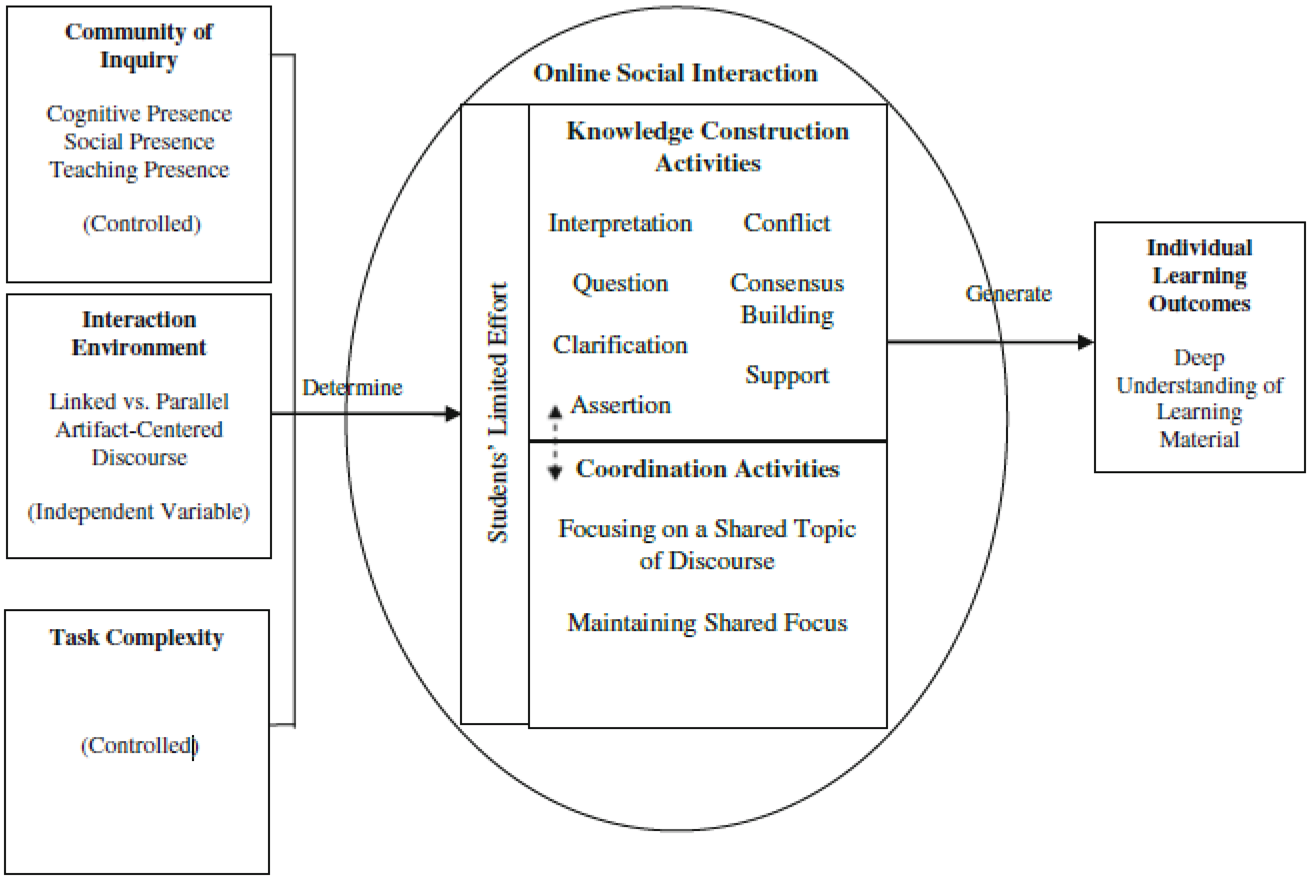
Online Discussion Example

- **Student 1:** *The relationship between perceived avoidability and avoidance motivation is negatively moderated by perceived threat so that it is weaker when perceived threat increases'. Is the message here that as the threat increases people go into denial?*
  - **Student 2:** *Frankly, I do not have the slightest idea what that is supposed to mean. Where did you read it?*
  - **Student 1:** *It is on page 14. See proposition 9.*

Open Source Annotation Tool



Motivation



Eryilmaz, E., Van der Pol, J., Ryan, T., Clark, M. P., & Mary, J. (2013). Enhancing Student Knowledge Acquisition from Online Learning Conversations. International Journal of Computer Supported Collaborative Learning, 8(1), 113-144.

A Problem with Existing Software

Students have difficulty with deep processing of complex instructional materials

- **Students gravitate to familiar (comfortable) topics and avoid challenging topics (Hewitt, 2005)**
- **Online discussions drift from one familiar topic to another, without diagnosing and resolving challenging misconceptions (Potter, 2008)**

Problem Demonstration

<u>Student 1:</u> *The paper's results reflect my own experiences. Information technology at my organization acts just in the ways described by the workers at the investigated organization. My colleagues and I act as knowledge brokers due to the nature of our jobs.*

<u>Student 2:</u> *I have also encountered the research problem in this paper in my own work when I consult with accountants, physicians, and attorneys*

Collaborative Knowledge Construction

<u>Student 1:</u> *I do not have clear understanding of "process-product." Does it mean that if a prescribed procedure (a process) is followed, the result (product) will be the same? Is this a cookbook approach to student achievement?*

<u>Student 2:</u> *I am also having hard time with this. My take is that depending on the content, the students, and the context, as the instructor I choose what seems to be the best. For me, explicit instruction does fit at times. Inquiry and constructivist methods also find a place. It really depends on the learning goal…but I guess if I'm the one deciding then it really isn't constructivist at all, is it?*

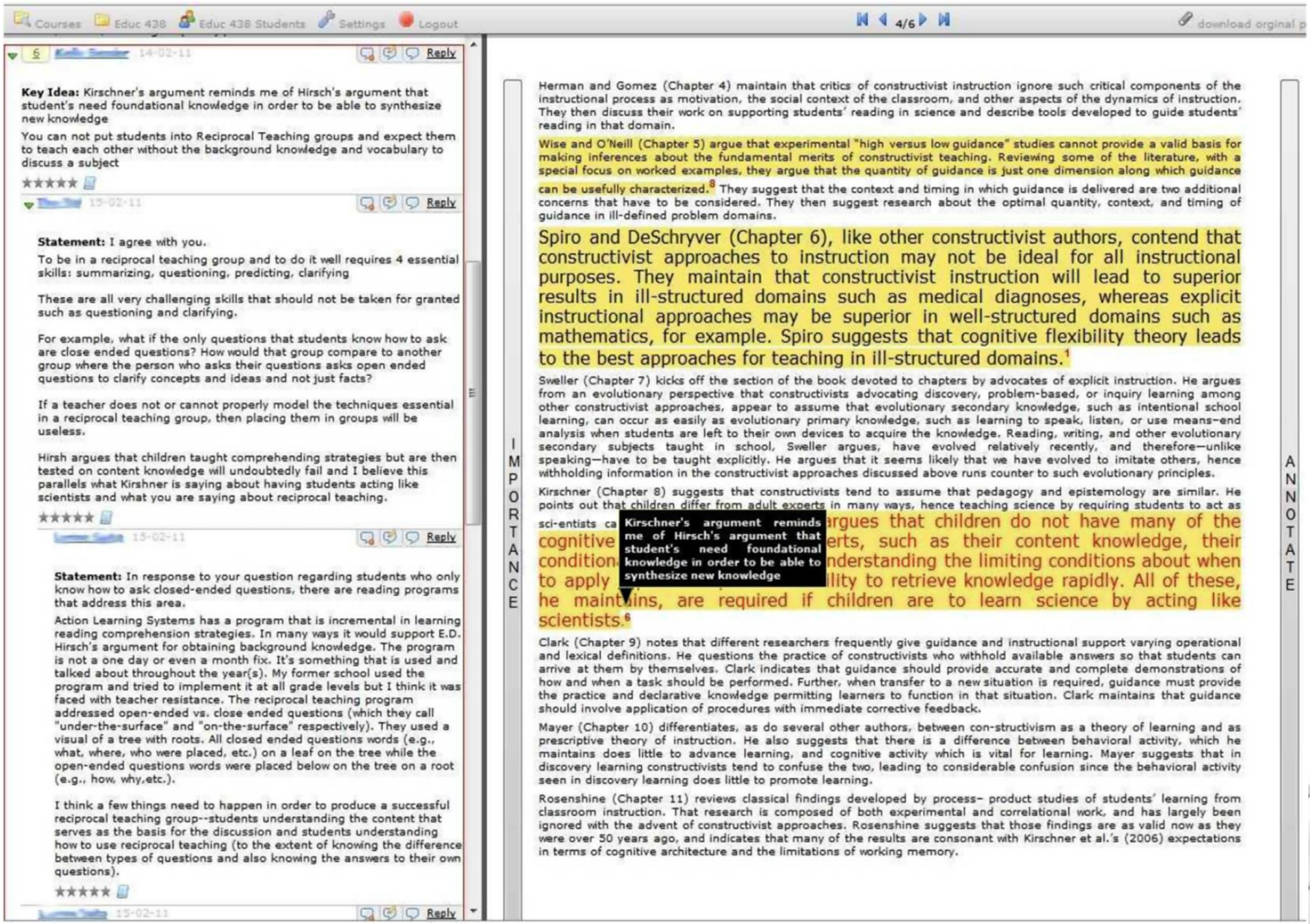
Define Solution Objectives

- Offer students an indirect way of focusing their attention on deep processing of challenging concepts

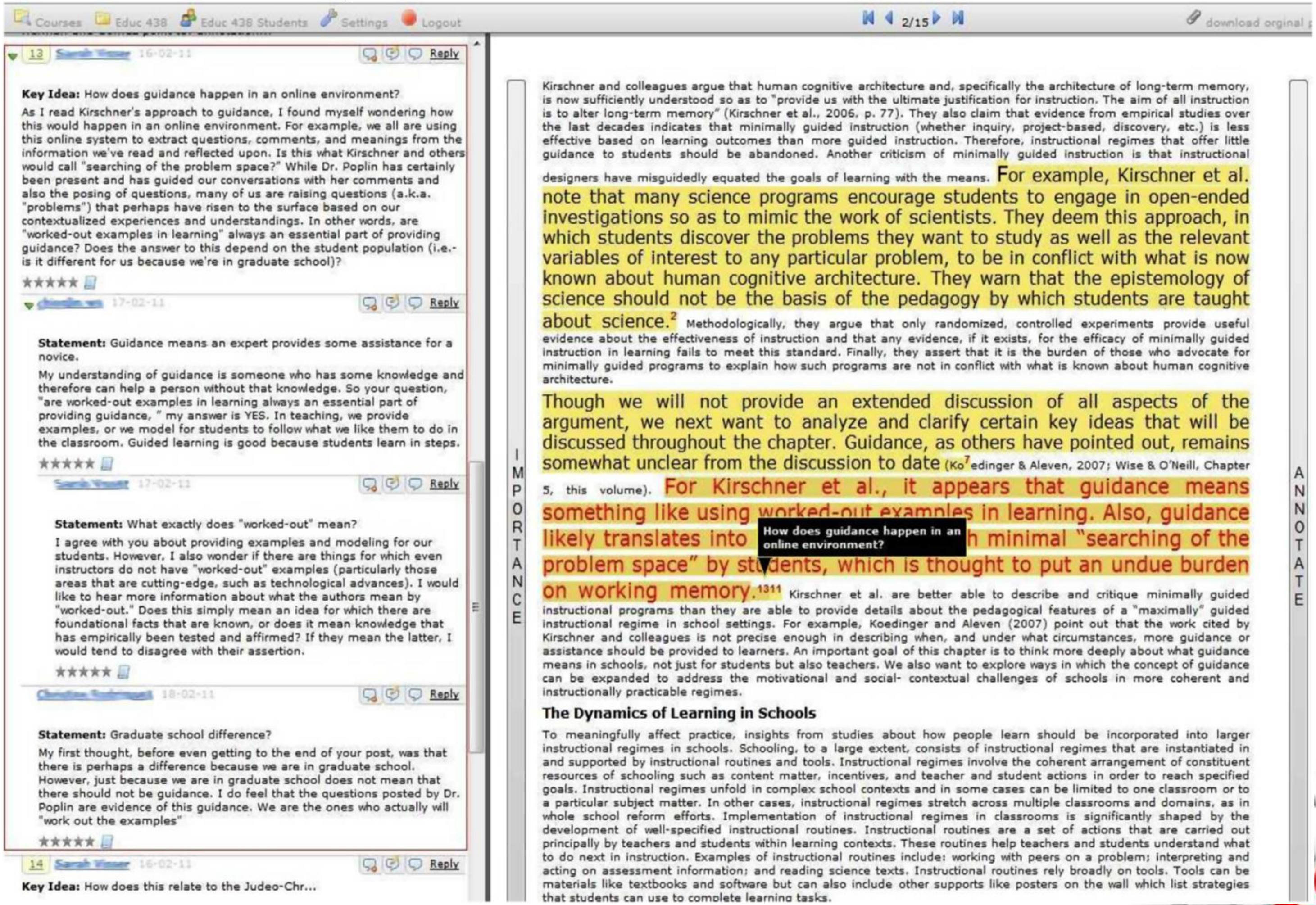
Design and development

- Font size is an effective visual property to capture attention in an involuntary and obligatory fashion (Lohmann et al., 2009)
- Faded instructor-based attention guidance functionality
- Peer-oriented attention guidance functionality

Faded-instructor based attention guidance functionality



Peer-oriented attention guidance functionality



Demonstration

Longitudinal Experiment with two small groups:

- Treatment group: Switched from instructor-based to peer-oriented guidance software
- Control group: No access to attention guidance

Evaluation-Discussion Focus

Condition	Discussion topic					
	1	2	3	4	5	Mean
Instructor-based attention guidance functionality						
Frequency of student annotations focusing on challenging concepts	9	12	10	7	14	10.4 (2.7)
Total number student annotations	14	17	12	9	19	14.2
Selection ratio of challenging concepts	64%	70%	83%	78%	74%	73%
Control software system						
Frequency of student annotations focusing on challenging concepts	3	8	6	5	7	5.8 (1.9)
Total number of student annotations	9	19	17	16	21	16.4
Selection ratio of challenging concepts	33%	42%	35%	31%	33%	35%

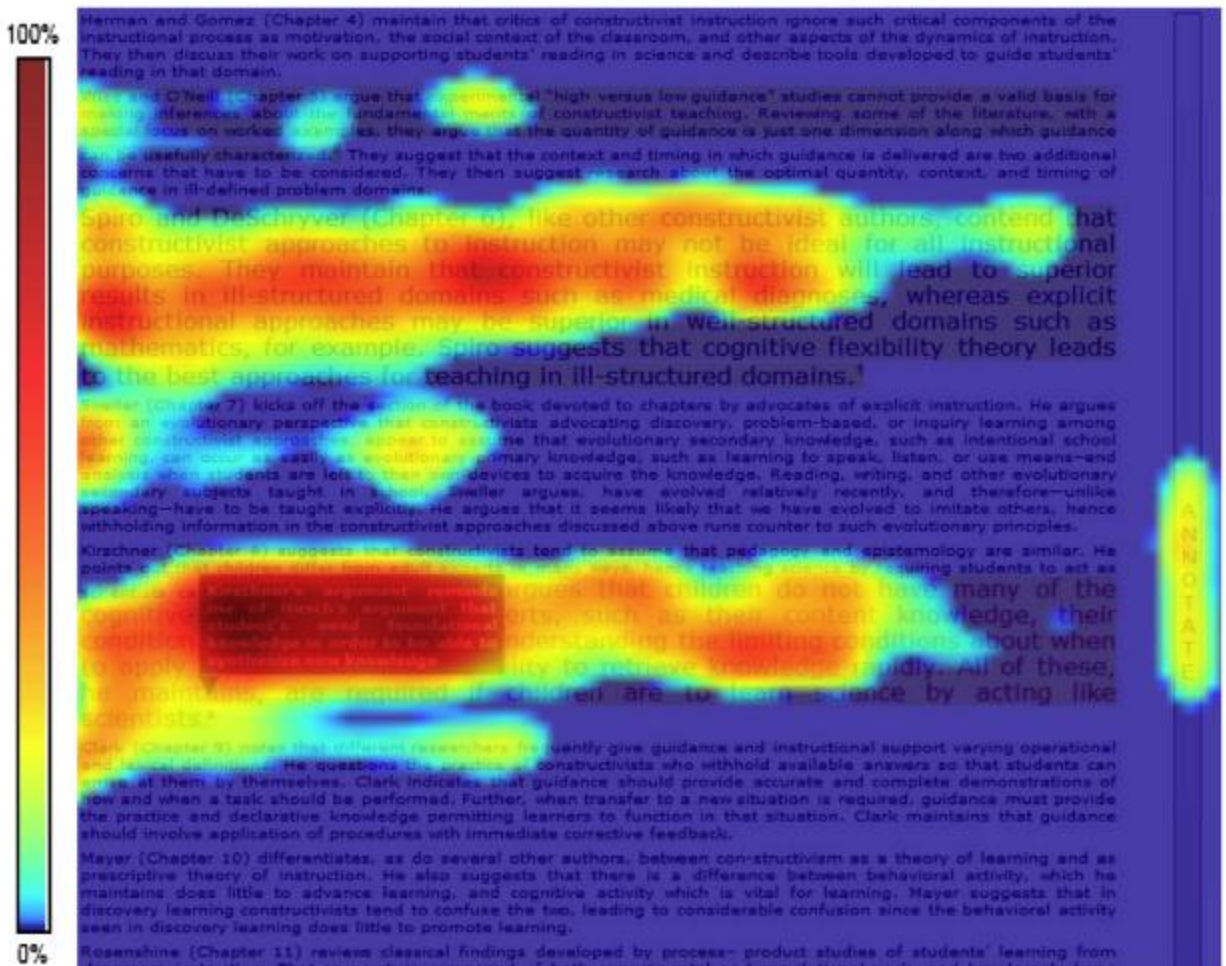
Note. Standard deviation in parenthesis.

Evaluation-Discussion Focus

Condition	Treatment group		Control group
	Instructor-based attention guidance functionality	Peer-oriented attention guidance functionality	
	Mean of 1st 5 topics	6th Topic	6th Topic
Frequency of student annotations focusing on challenging concepts	10.4	11	6
Total student annotations	14.2	16	21
Selection ratio of challenging concepts	73%	69%	29%

Evaluation-Discussion Focus

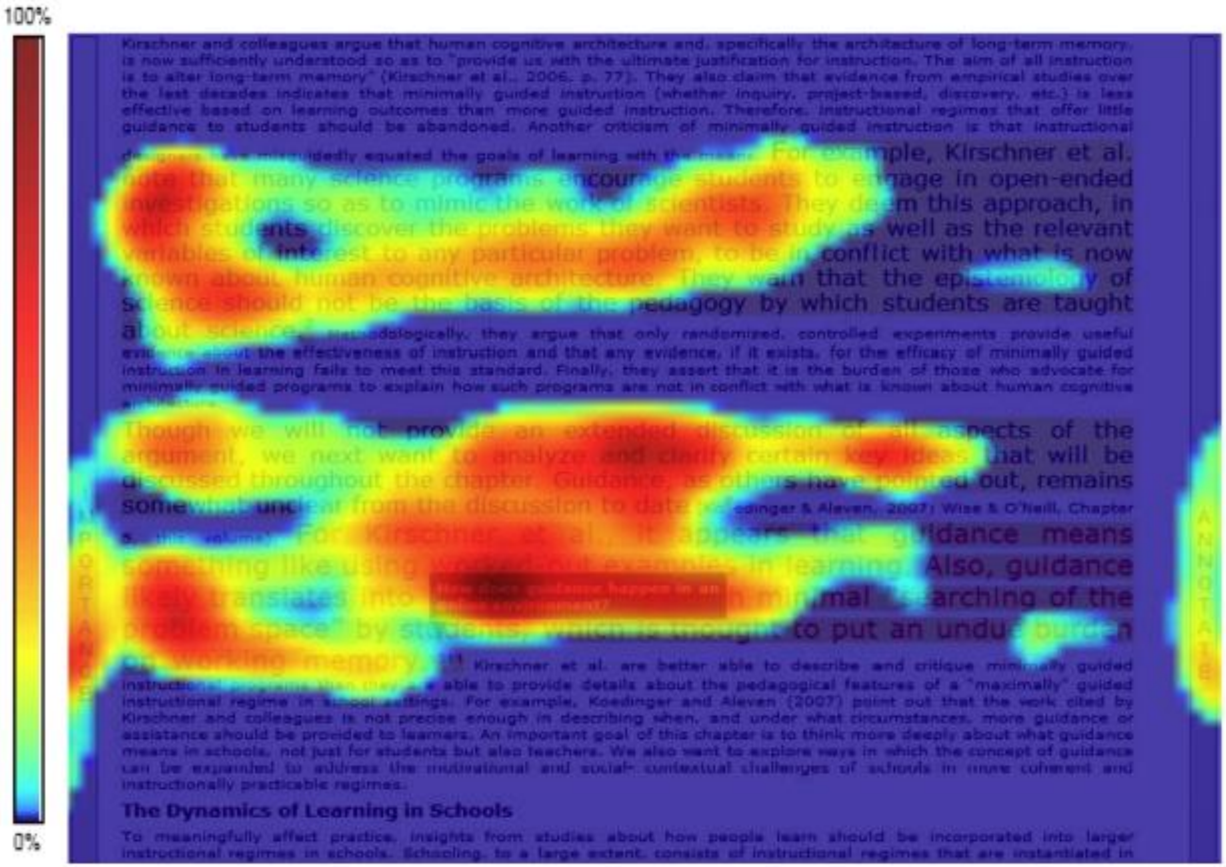
Instructor-based attention guidance
(10 students)



Evaluation-Discussion Focus

Peer-oriented attention guidance

(9 students)



Evaluation-Discussion Focus

Control Software

(8 students)

Evaluation-Message Content

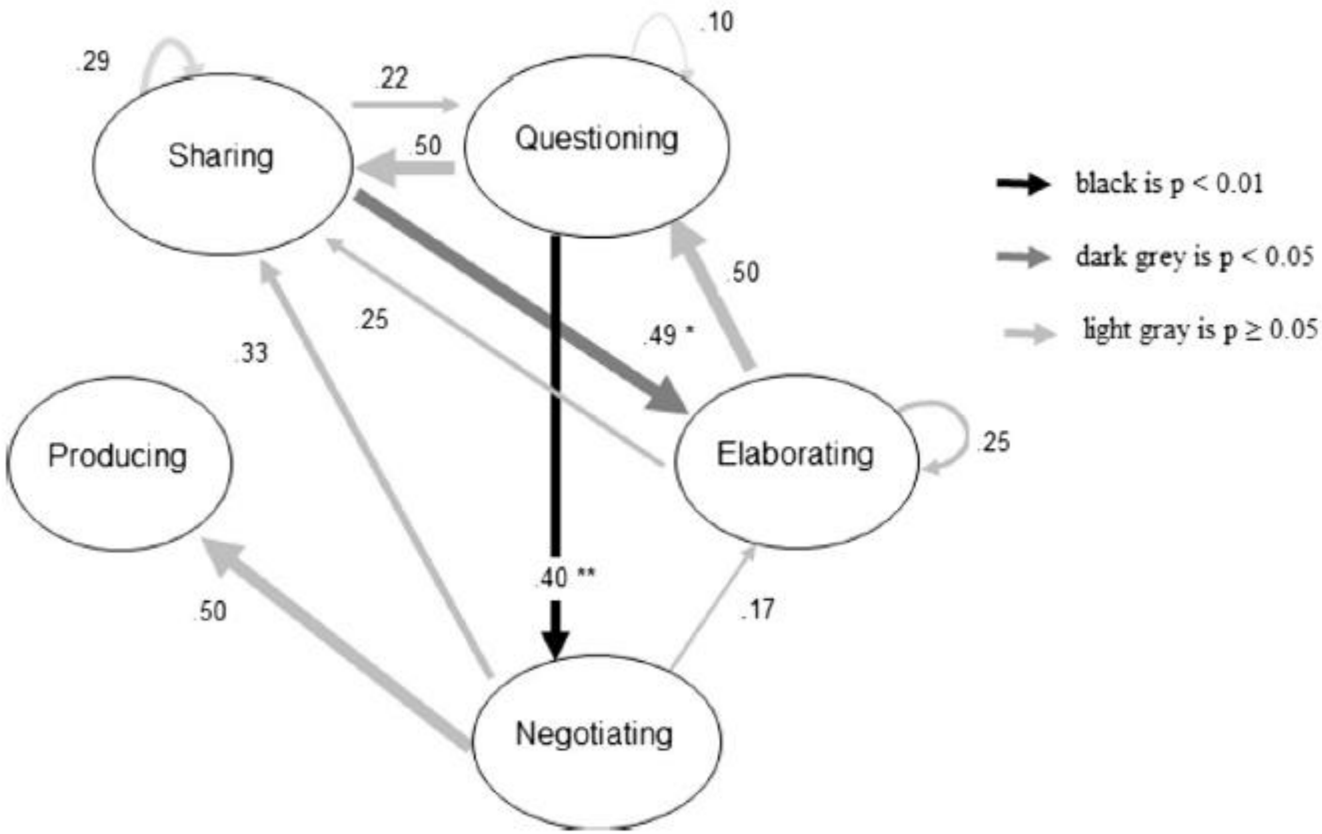
Messages		Instructor-based attention guidance functionality		Control software system		z	p
		Frequency	Proportion	Frequency	Proportion		
Task-related	Sharing	66	0.30	76	0.33	0.68	0.50
	Questioning	52	0.24	36	0.16	2.12*	0.03
	Elaborating	30	0.14	11	0.04	3.73***	<0.001
	Negotiating	23	0.11	5	0.02	3.90***	<0.001
	Producing	3	0.01	1	0.004	0.77	0.44
	Total task-related	174	0.80	129	0.56	5.43***	<0.001
Non task-related		43	0.20	102	0.44		
Total		217	1.00	231	1.00		

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

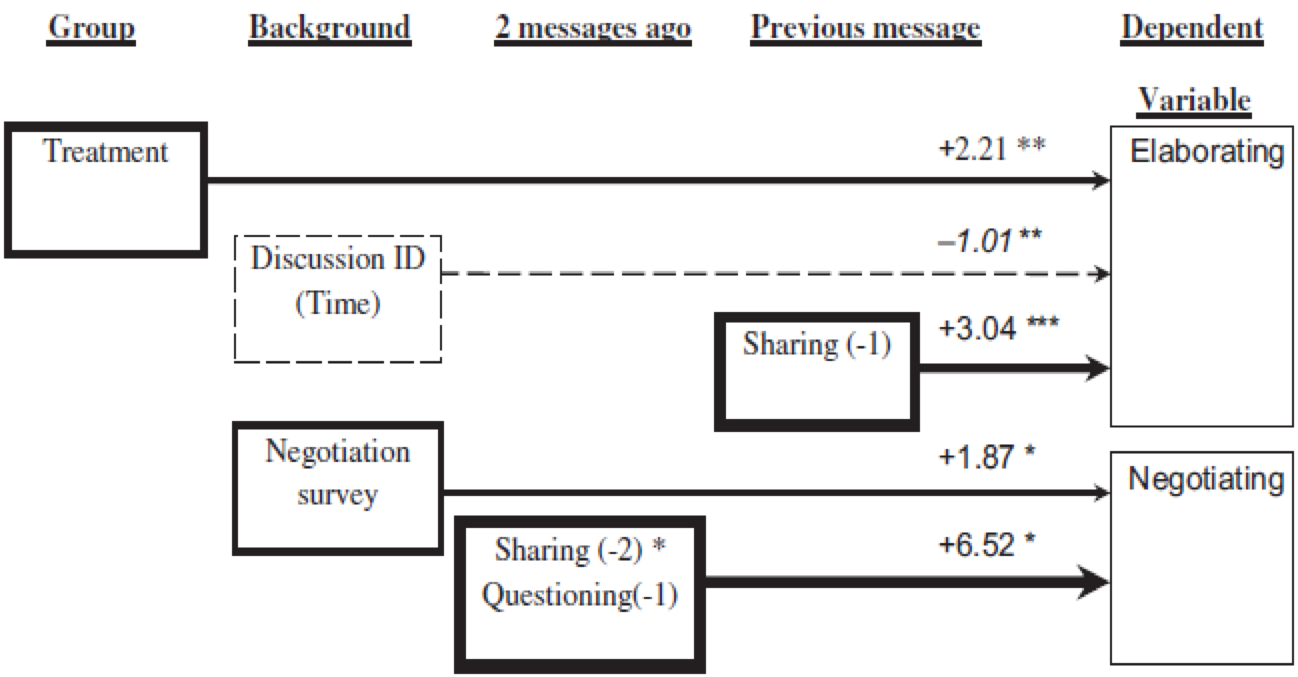
Evaluation-Message Content

Messages		Attention guidance functionality				Control software system	
		Instructor-based		Peer-oriented			
		Mean	Proportion	Frequency	Proportion	Frequency	Proportion
Task-related	Sharing	13.2	0.30	15	0.32	13	0.34
	Questioning	10.4	0.24	13	0.28	6	0.16
	Elaborating	6.0	0.14	5	0.11	1	0.03
	Negotiating	4.6	0.11	6	0.13	2	0.05
	Producing	0.6	0.01	0	0.00	0	0.00
	Total task-related	34.8	0.80	39	0.84	22	0.58
Non task-related		8.6	0.20	8	0.17	16	0.42
Total		43.4	1.00	47	1.00	38	1.00

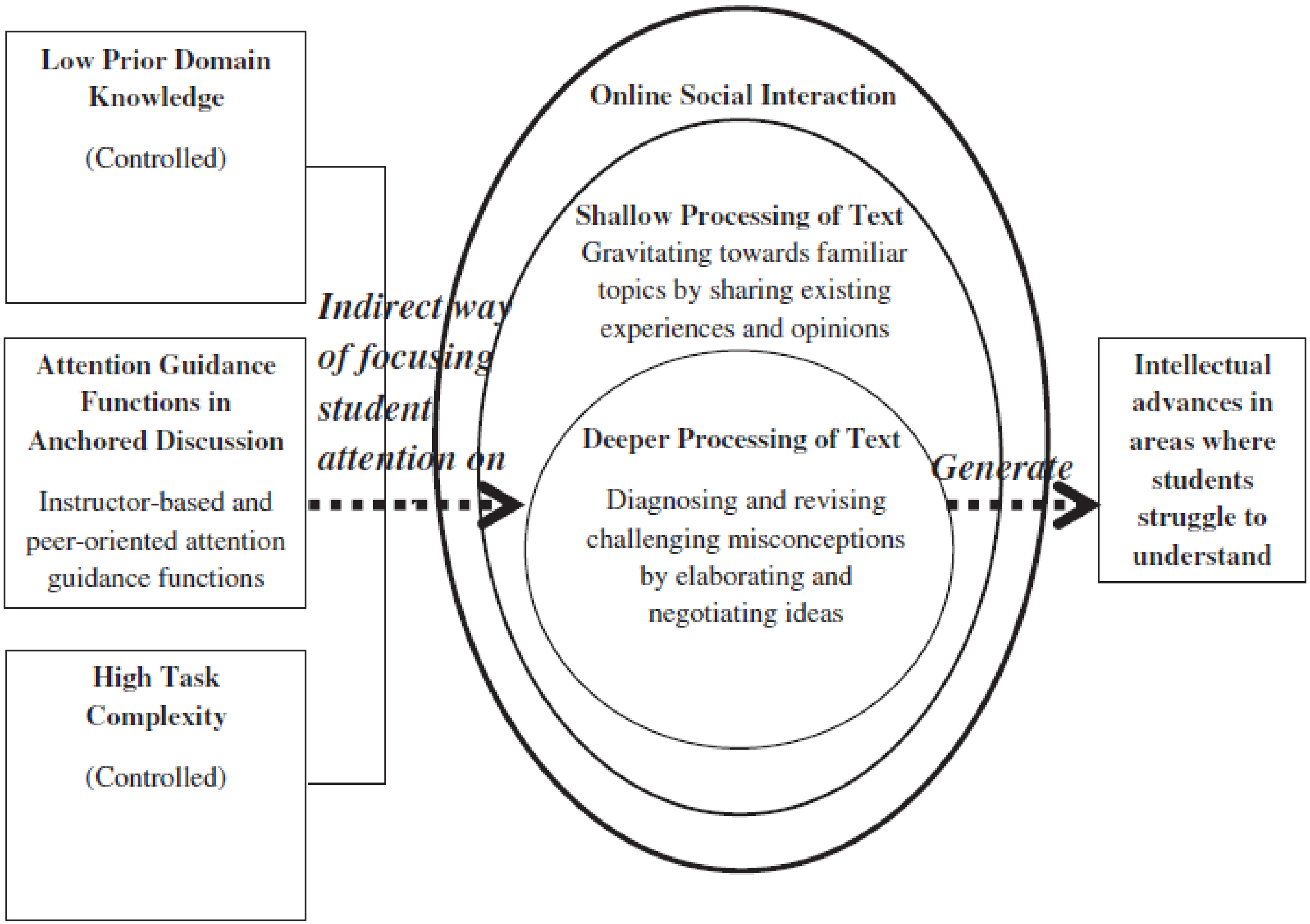
Evaluation-sequential organization of messages

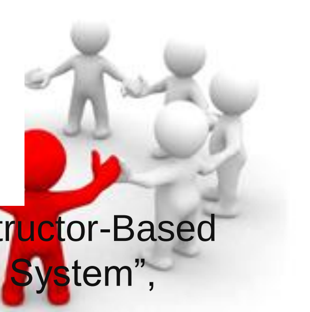


Evaluation-sequential organization of messages



Communication





Eryilmaz, E., Chiu, M. M., Thoms, B., Mary, J., & Kim, R. (2014). Design and Evaluation of Instructor-Based and Peer-Oriented Attention Guidance Functionalities in an Open Source Anchored Discussion System", Computers & Education, 71, 303-321.

Future Research Questions

- What are relationships among different types off technology-enhanced scaffolds and how can we fade them to facilitate adaptive web-based systems?
- If students become dependent on technology-enhanced scaffolds, do they interact less with peers and instructors?

More Information

- Eryilmaz, E., Chiu, M. M., Thoms, B., Mary, J., & Kim, R. (2014). Design and Evaluation of Instructor-Based and Peer-Oriented Attention Guidance Functionalities in an Open Source Anchored Discussion System", Computers & Education, 71, 303-321(**Impact Factor 2.775**)
- Eryilmaz, E., Thoms, B., Mary, J., Kim, R., Van der Pol, J. (2014). Attention Guidance in Online Learning Conversations, Proceedings of Hawaii International Conference on System Sciences (HICSS-47), January 6-9, 2014, Waikoloa, Hawaii
- Eryilmaz, E., Ryan, T., Poplin, M., & Mary, J. (2012). Re-Design and Evaluation of an Anchored Discussion System, Proceedings of Hawaii International Conference on System Sciences (HICSS-45), January 4-7, 2012, Maui, Hawaii. (**Nominated Best Paper**)

Thank You for Your Time

Your Comments and Questions are welcomed.

Please address feedback to:

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