The Effect of Anchoring Online Discussion on Collaboration and Cognitive Load

Evren Eryilmaz, Nimer Alrushiedat, Sumonta Kasemvilas, Justin Mary, J. van der Pol
Claremont Graduate University (USA) and Utrecht University (NL)

Claremont GRADUATE UNIVERSITY

Universiteit Utrecht

Agenda

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The Pressing Problem

- Students often do not naturally engage in constructive interactions that are productive for learning
  - Discussion threads are short and participation rates are low
  - Discussions tend to consist mostly of independent monologues instead of true knowledge construction dialogues
    - Students rarely explain or elaborate on their own or others' contributions
    - Students are reluctant to evaluate others' ideas

Cognitive Load Theory

- The load on mental resources during thinking and reasoning

- Three types of load:
  - Intrinsic: Difficulty level of the instructional material
  - Extraneous: The way in which information to be learned is presented
  - Germane: Processing, construction, and automation of schemas

- Cognitive load assessment factors: Mental load, mental effort, and performance [1]

[1] Paas, F., & Van Merriënboer, J. J. G. (1994).
Instructional control of cognitive load in the training of complex cognitive tasks.
Educational Psychology Review, 6(4), 351-371.

Anchored Discussion System

- **<u>Two Fundamental Characteristics:</u>**
    1. Online presence of the learning material
    2. Potential to annotate fragments of the learning material, thus providing messages with a frame of reference

- **<u>Anchor Definition:</u>** Shared, learner-constructed contextual representation of a topic that students find worthy of discussion

- **<u>Theoretical Rationale:</u>** Situated action theory to rationalize the use of an anchored discussion system in an educational setting

Anchored Discussion System *[www.annotatietool.nl]*

Two context creating effects facilitate the following:

- On-screen presence of learning material → Context for collaboration and more meaning oriented processing of literature [2] → Elaboration of ideas and evaluations of reasoning processes

- Providing messages with a frame of reference →Easier referring and higher communicative efficiency [2] → Lower Extraneous Load

[2] Van der Pol, J. (2009). Online Learning Conversations: potential, challenges, and facilitation. In Payne. C. R. (ed.) *Technology and Constructivism in Higher Education: Progressive Learning Frameworks.* Hershey, PA: IGI-Global.
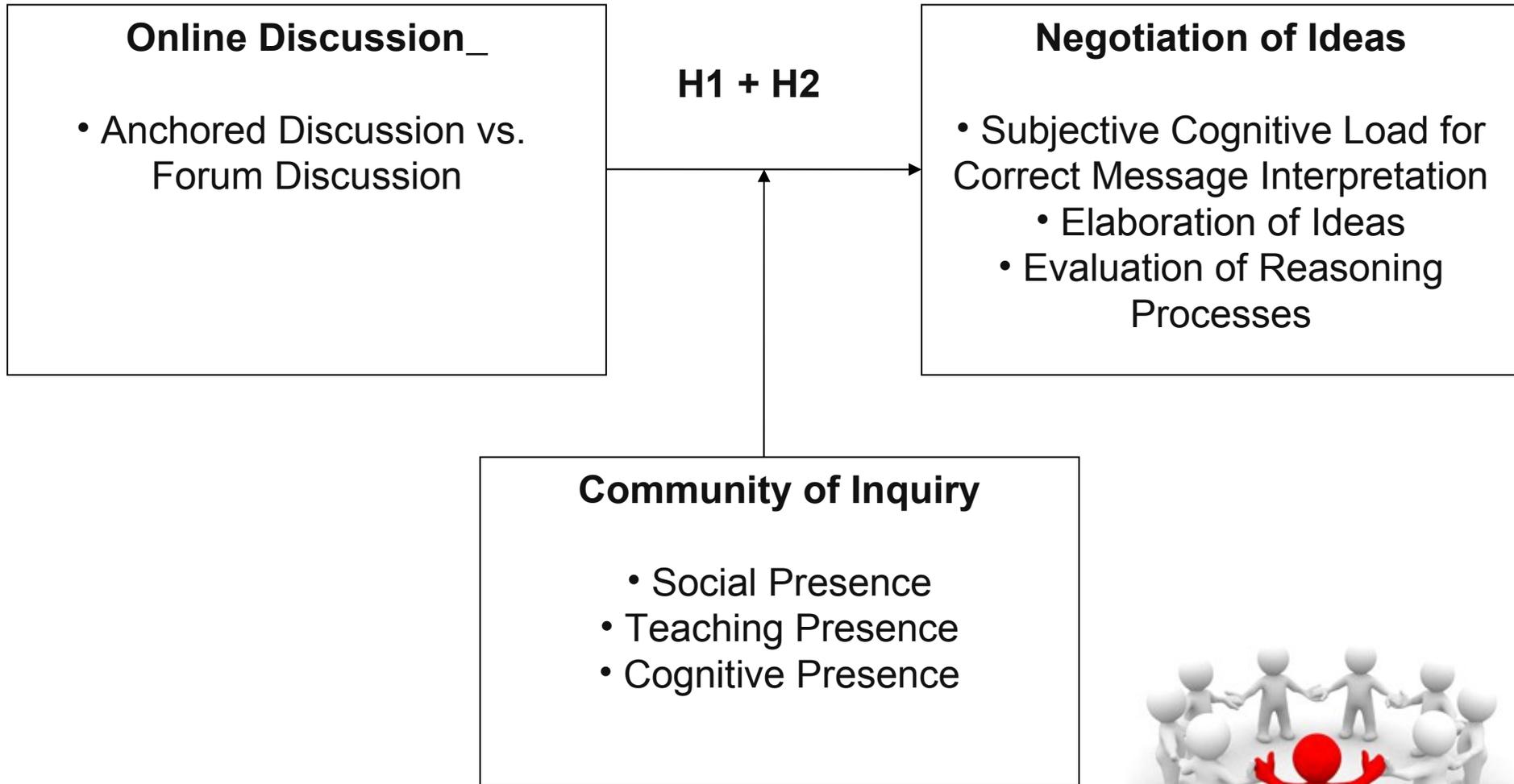
Research Goals

- Investigate the role of technology to facilitate a natural setting for collaborative meaning negotiation and knowledge construction

- Develop an understanding of cognitive load as a factor supporting or inhibiting effective online discussion

Research Question: *How does anchoring technology influence negotiation of ideas in online discussion?*

Research Model and Hypotheses

Online Discussion_

• Anchored Discussion vs. Forum Discussion

H1 + H2

Negotiation of Ideas

• Subjective Cognitive Load for Correct Message Interpretation
• Elaboration of Ideas
• Evaluation of Reasoning Processes

Community of Inquiry

• Social Presence
• Teaching Presence
• Cognitive Presence

Research Model and Hypotheses

H1: Anchoring discussion leads to more task-oriented communication and less need for social and planning comments leaves more time and effort for the creation of elaboration of ideas and evaluations of reasoning processes.

Assessment Technique: Content analysis instrument developed by Veerman & Veldhuis-Diermanse [6] and validated by Schellens &Valckle [7] to analyze academic discourse

Non-Task-Oriented Communication: Planning, technical, social, and nonsense

Task-Oriented Communication: Presentation of new information, explanation, and evaluation

[6] Veerman, A., & Veldhuis-Diermanse, E. (2001). Collaborative learning through computer-mediated communication in academic education. In P. Dillenbourg, A. Eurelings, & K. Hakkarainen (Eds.), European perspectives on computer-supported collaborative learning. Proceedings of the first European conference on CSCL. Maastricht: McLuhan Institute, University of Maastricht.

[7] Schellens, T. & Valckle, M. (2005). Collaborative learning in asynchronous discussion groups: What about the impact on cognitive processing? *Computers in Human Behavior*, 21(6), 957-975.

Research Model and Hypotheses

H2: Anchoring discussion leads to more efficient communication as it reduces cognitive load involved in correctly interpreting messages

Assessment Technique: Two rating scale measurements consistent with each other [8]

Short Self-Report Instrument: Single question of overall mental load with seven point mental effort rating scale [9]

NASA Task Load Index (TLX): Mental demand, physical demand, temporal demand, performance, effort, and frustration [10]

[8] Windell, D. & Wiebe, E. N. (April, 2007). *Measuring Cognitive Load in Multimedia Instruction: A Comparison of Two Instruments*. Presented at the Annual meeting of the American Educational Research Association, Chicago, IL.

[9] Paas, F., Tuovinen, J. E., Tabbers, H., & Van Gerven, P. W. M. (2003). Cognitive Load Measurement as a Means to Advance Cognitive Load Theory. *Educational Psychologist, 38*(1), 63-71.

[10] Hart, S. G., & Staveland, L. E. (1988). Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. *Human mental workload, 1*, 139–183.

Research Methodology

- **<u>Pilot Study Purpose:</u>** Assess the usability of the anchored discussion system, familiarize researchers with content analysis, and test cognitive load assessment techniques
- **<u>Pilot Study Subjects:</u>** Six doctoral students attending to an introduction to research methods course
- **<u>Main Study:</u>** Quasi-experimental design involving two groups of junior level undergraduate students in two sessions of a statistics course, varying technology
- **<u>Main Study Subjects:</u>**
  - **Treatment Group (n=39):** Anchored discussion
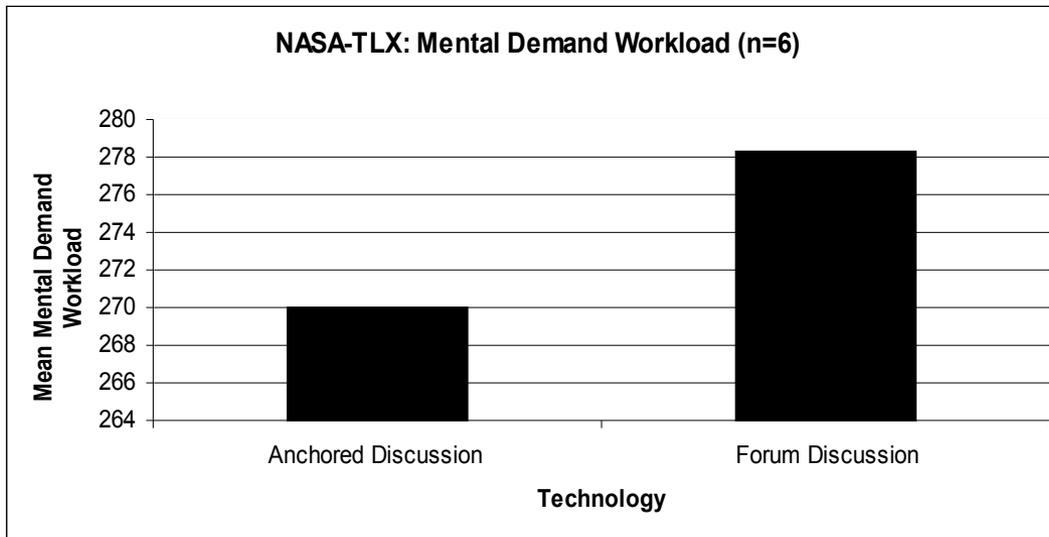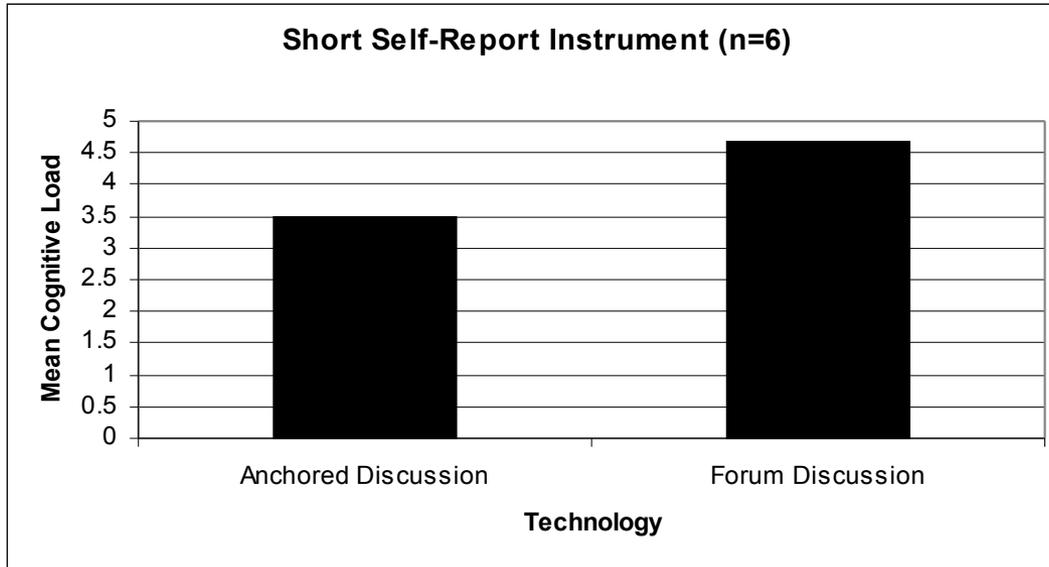 - **Control Group (n=39):** Forum discussion

Pilot Study Findings

- Usability:
  - Some students did not use the annotating feature
  - Errors and multiple post issues when making a comment
  - Double column format and up-down scrolling made document reading difficult
- Cognitive Load:
  - Low subjective cognitive load when correctly interpreting social comments and comments focusing on the parts of the reading which subjects thought too easy
  - High subjective cognitive load when interpreting a comment focusing on the parts of the reading which the subject did not understand

Pilot Study Findings

Short Self-Report Instrument (n=6)

Bar chart titled "Short Self-Report Instrument (n=6)". Y-axis: Mean Cognitive Load (0 to 5). X-axis: Technology. Anchored Discussion ≈ 3.5, Forum Discussion ≈ 4.65.

NASA-TLX: Mental Demand Workload (n=6)

Bar chart titled "NASA-TLX: Mental Demand Workload (n=6)". Y-axis: Mean Mental Demand Workload (264 to 280). X-axis: Technology. Anchored Discussion = 270, Forum Discussion ≈ 278.3.

Main Study Findings (1)..

- Preliminary surveys revealed no significant difference between the groups on social presence, teaching presence, and cognitive presence [11, 12 ,13]

- Three researchers independently coded a total of 693 messages
  - The quality of the coding is assessed by determining Cronbach's alpha
  - The recommended setting is $\alpha > 0.8$
  - Cronbach's alpha value = 0.87

[11] Swan, K., & Shih, L. F. (2005). On the nature and development of social presence in online course discussions. *Journal of Asynchronous Learning Networks, 9*(3), 115-136.

[12] Arnold, N., & Ducate, L. (2006). Future foreign language teachers' social and cognitive collaboration in an online environment. *Language Learning & Technology, 10*(1), 42-66.

[13] Shea, P. J., Pickett, A. M., & Pelz, W. E. (2003). A follow-up investigation of "teaching presence" in the SUNY Learning Network. *Journal of Asynchronous Learning Networks, 7*(2), 61-80.

Main Study Findings (2)..

	Initial Pilot		Main Study-Control		Main Study-Treatment	
	Number	Percentage	Number	Percentage	Number	Percentage
Non-Task Related Communication						
Planning	0	0%	9	5%	11	3%
Technical	0	0%	0	0%	0	0%
Social	1	1%	41	21%	30	7%
Nonsense	0	0%	1	1%	0	0%
Task Related Communication						
New Idea						
Facts	7	9%	10	5%	31	7%
Experience /Opinions	38	51%	86	45%	147	34%
Theory	1	1%	0	0%	4	1%
Explanation	14	19%	28	15%	115	27%
Evaluation	14	19%	15	8%	90	21%
Total	75	100%	190	100%	428	100%

The treatment group produced more:

- task-oriented messages, $\chi2$ (1) = 30.95, *p* <0.01

- explanations, *t*(618) = 3.33, p<0.001

- evaluations, *t(*618) = 3.70, p<0.001

Results provide support for H1

Main Study Findings (3).

Subjective Cognitive Load for Correct Message Interpretation

- – Short Self-Report Instrument: $t(76)$ = -1.83, p=0.04, one tailed
- – NASA-TLX: Based on 27 students in each group
  - Mental Demand Workload, $t(52)$ = -1.92, p=0.03, one tailed
  - Mental Effort, $t(52)$ = 1.17, p=0.12, one tailed
  - Performance, $t(52)$ = 1.22, p=0.11, one tailed

Findings provide support for H2

Conclusion

- Greater proportions of elaboration of ideas and evaluations of reasoning processes in collaborative knowledge construction when the anchored discussion system used for deep processing of literature

- Design features of a discussion system may reduce the risk of misinterpretations when negotiating ideas in a community of inquiry to construct shared meaning
  - The system has the most significant effect on cognitive load for students who perceive selected online discussion material challenging, but not too difficult to give up collaborative knowledge construction in frustration

Next Steps

- Generalizability of findings to other learning context
  - Replications with other populations in different subject areas
- Content analysis provides little information to explain or predict the relationship between threaded messages
  - Examine how patterns of interaction relate to collaborative knowledge construction process between the two systems
- Investigate the functional difference of the anchored discussion system to another system that places threaded discussion next to an academic text without connecting messages to specific sections of that text

Comments & Questions

Thank you for your attention.

Please address feedback to:

evren.eryilmaz@cgu.edu