The Influence of Backchannel Communication on Cognitive Load

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Abstract

Synchronous online conferencing systems expand opportunities for real-time interaction, but foster parallel channels of communication. Visual and audio channels facilitate instructional presentation in the main channel of communication while text-chat features support participants' backchannel exchanges. Within the context of cognitive load theory and research, this paper considers whether backchannel communication helps to manage intrinsic load and optimize germane load through improved facilitation of computer-mediated discourse or whether the backchannel poses a distraction that unnecessarily increases extraneous cognitive load.

Keywords: distance learning, interaction, communication, backchannel

Backchannel Communication

Synchronous computer-mediated communication (CMC) features within online conferencing systems offer distance education instructors and learners expanded opportunities for interaction, communications, and content sharing. The latest forms of synchronous web-based conferencing technology, such as Elluminate Live and Adobe Connect, offer real-time audio and visual interfaces, along with public and private text-chat, Internet browsers, polling tools, application sharing, and whiteboards. Beyond a one-way broadcast of the primary instructional message, these synchronous conferencing technologies support simultaneous multi-channel communication among all participants and foster the learners' real time interactions with the instructional content, with the instructor, and with peer learners. No longer passive recipients of a single-channel instructional presentation, distance learners are now able to utilize the interactive features of the synchronous web conferencing system to annotate directly on the presentation slides while the presenter is speaking, route or receive files, send and receive links to web sites during the presentation, type viewable notes to the class in the margins of the presentation window, or engage in text-based conversations while the live instructional presentation is delivered.

While the audio and visual conferencing features tend to facilitate the main channel of communication in the live sessions, the text-chat feature often supports spontaneous and unfacilitated parallel (backchannel, sidebar, or side-talk) exchanges among participants which occur simultaneously with the instructional presentation. The opportunities for parallel communication and interaction is sparking debate among researchers and practitioners regarding what computer-mediated activities learners should engage in during live instructional sessions (Fried, 2008). Learners' backchannel communication and interactions during lecture are viewed by educators as either a bold step forward in instruction that offers a new opportunity to facilitate increased content and human interaction or a form of virtual note passing that imposes an unnecessary distraction to the learning task at hand (Guess, 2008).

While many studies have examined asynchronous CMC in distance education, far less research has been conducted on distance learners' experiences within multimodal synchronous learning environments (Bower & Hedberg, 2010). Further, beyond essays considering the use of text-chat during live conference proceedings or qualitative reviews examining synchronous CMC to facilitate classroom discussion (Yardi, 2006, 2008), little research has examined learner experiences with computer-mediated backchannels in a distance learning environment. The objective of this paper is to consider findings from other areas of research regarding learner interaction with instructional content, other learners, and the instructor to begin to assess how this new form of backchannel communication could influence the student's ability to learn.

As discussed below, research based on cognitive load theory suggests the parallel interaction may pose a negative distraction that unnecessarily increases extraneous cognitive load. However, the additional opportunities for real-time peer and teacher interaction and support within the parallel channels of CMC may enhance engagement, improve the facilitation of computer-mediated discourse, and foster student-to-student reflection and discussion of the to-be-learned subject matter. Given that cognitive load is a central consideration in interactive multimedia learning (Moreno & Mayer, 2007), the primary task of this paper is to consider where synchronous computer-mediated backchannel communication during instructional presentation falls within the cognitive load equation.

Cognitive Load Theory and Research

Cognitive load theory (CLT) suggests that working memory imposes processing limitations which impact a learner's ability to process, encode, and retrieve information (Sweller

& Chandler, 1994). CLT is concerned with the learner's limited working memory processing capacity and the combined effect of intrinsic, extraneous, and germane cognitive load (Pociask & Morrison, 2004). *Intrinsic* cognitive load is imposed by the inherent nature of the to-be-learned information while *germane* cognitive load is associated with processes that assist in learning, including processes facilitating schema acquisition and automation (van Merriënboer & Sweller, 2005). *Extraneous* cognitive load does not support learning and can be imposed by inappropriate instructional design choices, such as the instructional message design, the instructional presentation, and interface choices related to the delivery mode (visual or verbal), modality (text or narration), and spatial arrangements on the page or screen (Lee, Plass, & Homer, 2006).

Fundamental to CLT is the notion that the learning environment should eliminate irrelevant cognitive activities which do not lead to schema acquisition and automation and hamper the processing of to-be-learned material (Sweller & Chandler, 1994). Based on CLT, the instructional design of the learning environment should attempt to minimize extraneous load, optimize germane load, and manage intrinsic load (Kester, Kirschner, & van Merriënboer, 2006). Sweller and Chandler (1994) suggest that high cognitive load is directly related to interactivity caused by either the nature of the to-be-learned material (intrinsic cognitive load) or by the presentation (extraneous cognitive load). The to-be-learned material is considered to have high interactivity if there are numerous elements which must be processed simultaneously (van Merriënboer & Sweller, 2005). If the element interactivity is low (hence the intrinsic cognitive load is low), then extraneous load may be less of a concern; but in complex learning situations where the intrinsic element interactivity is high, it is necessary to carefully manage the learning environment to avoid unnecessary instructional interactivity in order to reduce extraneous cognitive load (Sweller & Chandler, 1994). Thus, a concern is whether synchronous learning environments that facilitate communication through multiple channels unnecessarily increase extraneous load.

Extraneous Cognitive Load

Are the parallel interactions a distraction that could and should be eliminated to reduce extraneous load? Given the similarity between backchannel interactions and practices which are outside acceptable traditional classroom norms, such as note passing or whispering to peers while the presenter is speaking, it is understandable why some would find backchannel interactions as distractions to the learning task at hand.

Theory and research may support the belief that learner backchannel interactions unnecessarily increase extraneous cognitive load. Research suggests that instruction requiring learners to devote their attention to multiple sources of information may unnecessarily cause extraneous cognitive load (Sweller & Chandler, 1994). Further, some research on laptop use in the classroom lecture setting suggests that learners' computer-mediated interaction during lecture is a potential source of distraction and cognitive overload and that students' laptop use is negatively related to several measures of learning when the laptop use is not purposefully integrated into the lecture the (Fried, 2008).

Moreno and Mayer (2007) examined interactivity as a characteristic of the multimodal learning environment in which the interactivity results in a variation in the instruction based on the learners' actions, including (a) *dialoguing* in which the learner asks questions and receives feedback, (b) *controlling* in which the learner establishes the pace or order of presentation, (c) *manipulating* in which the learner sets aspects of the presentation, (d) *searching* in which the learner seeks new information, and (e) *navigating* in which the learner selects from among content choices. Moreno and Mayer suggest the interactivity should be considered on a continuum from *no interactivity* to *high interactivity* and conclude that the challenge for designers working in interactive multimodal learning environments is to use the interactivity to increase generative cognition while at the same time reducing extraneous cognitive load imposed by the interactivity. As such, an important question is whether the interactivity involved with backchannel interactions is extraneous load within the learning environment or germane to the process of learning?

Germane Cognitive Load

Instructional activities that encourage mental effort in schema construction and automation are viewed as processes that optimize germane cognitive load (van Merriënboer & Sweller, 2005). Computer-mediated instructional technologies have long been valued for their ability to facilitate direct teaching, but also to assist learners as they actively select, organize, and integrate new information (Winn, 2004). Some suggest that synchronous computer-mediated discussion helps learners move from surface understanding to deeper learning as they reflect and respond to questions from peers and the instructor (Havard, Jianxia Du, & Olinzock, 2005) which is viewed by some as a difference between facilitating information acquisition and supporting knowledge construction (Moreno & Mayer, 2007). Are backchannel interactions germane to the learning process as part of effective presentation, communication, and dialogue to support the learner? Do these interactions help learners engage and reflect upon the material, create meaning from the presented content, and process the to-be-learned material within memory? As discussed below, research suggests that the parallel CMC may optimize germane cognitive load by promoting task engagement and supporting computer-mediated discourse. In addition, the increased opportunities for learner-to-other interaction may foster increased levels of teaching, cognitive, and social presence thereby leading to more meaningful learning outcomes.

Task engagement. Research suggests that when integrated within the course and monitored by the instructor, computer use during classroom presentation can enhance classroom interactions and learner participation which, in turn, increases engagement, motivation, and active learning (Fried, 2008). While *non-directed* computer use during classroom presentation (such as checking personal e-mail) can lead to learner distraction, directed computer use has been found to facilitate the learners' understanding of the subject material, support immediate feedback and help, promote multiple interactions among learners and instructors, and offer learners the ability to share work, ideas, and learner interpretations (Barak, Lipson, & Lerman, 2006). In addition, due to factors such as increased anonymity, a sense of altered responsibility, and novel or unstructured situations, research suggests that some participants in synchronous CMC find the physical separation provides a freedom from distraction which allows them to become more self-disclosing and engaged in the task at hand (Coleman, Paternite, & Sherman, 1999). These findings suggest that the text-based backchannel may lead to greater learner task engagement.

Conversational effectiveness. Communication research suggests that technology mediated discourse differs from face-to-face communication and is generally characterized by longer turns, fewer interruptions, less overlaps, and increased formality in switching among speakers which may affect conversational effectiveness or the degree to which the mutual conversational goals are achieved (Marshall & Novick, 1995). In addition, decreased levels of communication (as compared to face-to-face communication) may be the result of reduced use of speech acknowledgements or typical social greetings (DeSanctis & Monge, 1998). While research indicates that participants engaging in CMC conversation may experience difficulty in establishing meaning of information and managing feedback in conversation which may negatively affect message understanding, attention to maintaining mutual understanding across the group can help to ensure effective communication (DeSanctis & Monge, 1998).

The classic Shannon and Weaver (1963) communication model focuses on a single channel from sender to receiver and suggests an autonomous view of conversation in which the listener passively receives information delivered from the speaker. However, others argue communication is not just for information transmission, but also for co-construction of the message in which dialogue evolves from the *reciprocal influence* between narrators and listeners (Bavelas, Coates, & Johnson, 2000). Dialogue analysis research suggests that speakers monitor their own speech and adjust their presentations based on their assessments of the listeners' level of understanding (Clark & Krych, 2004). As such, dialogue consists of two types of activity, including (a) support for the primary presentation of information and (b) management of the dialogue itself, facilitated in both a front (or main) channel with the primary speaker and in a backchannel including the speech and signals from others occurring at same time as primary speaker's turn (Bangerter & Clark, 2003). Cogdill, Fanderclai, Kilborn, and Williams (2001) propose that backchannel interactions in digital conversations fall into one of five categories, including (a) *process-oriented* interactions which steer the main channel discourse, (b) *content-oriented* interactions which respond to the content in the main channel, (c) *participation-enabling* interactions which include assistance to participants, (d) *tangential* interactions which branch from or continue a completed main channel discussion , and (e) *independent* interactions which are private and unrelated to the main channel.

Meaningful learning through critical inquiry and discourse. Does the communication and interaction within the backchannel foster critical discourse and co-creation of knowledge? Could the synchronous backchannel provide support for more immediate meaningful reflection?

Social constructivists view synchronous CMC technologies as vehicles to support student to student co-creation of meaning and understanding (Paulus, 2007). The Community of Inquiry (CoI) was proposed as a conceptual framework for the optimal use of text-based asynchronous CMC to support critical thinking, critical inquiry, and discourse among distance education students and teachers (Garrison, Anderson, & Archer, 2000). Garrison et al. (2000) suggest the CoI as a guide to student and teacher interaction and communication to optimally support the learning process. The focus of the CoI is on facilitating critical reflection on the part of the learner and critical discourse among the teacher and peer learners. The CoI framework suggests that distance learning environments supported by CMC must include three essential elements, cognitive presence, social presence, and teaching presence, in order to foster the development and practice of higher-order thinking skills.

Cognitive presence is defined within the CoI framework as the extent to which distance learners construct meaning through both critical reflection and discourse, and is suggested to be a vital element in critical thinking (Garrison et al., 2000). Cognitive presence is operationalized through a group-based inquiry process focusing on four phases of critical inquiry, including (a) the triggering event, (b) exploration, (c) integration, and (d) resolution. Social presence is the degree to which learners feel connected while engaging in mediated communication. Some argue that while social presence alone will not ensure the development of critical discourse, it is difficult for such discourse to develop without it (Garrison & Cleveland-Innes, 2005). Teaching presence is described as a binding element in a CoI which influences the development of both cognitive and social presence through the direction and leadership of the educational experience.

CoI research suggests that perceptions of social presence, cognitive presence, and teaching presence are related to perceptions of learning by students (Arbaugh, 2008), yet it remains unclear whether the students' perceptions of learning and community are associated with critical discourse and meaningful learning (Rourke & Kanuka, 2009). While studies of learner perceptions suggest that most learners report achieving the *highest* levels of cognitive presence (Shea & Bidjerano, 2009), these findings are in sharp contrast to studies which suggest that learners in most CMC supported environments, which tend to rely heavily on asynchronous interactions, rarely move beyond sharing and comparing of information (Gunawardena, Lowe, & Anderson, 1997; Paulus, 2007).

Taken together, theory and research suggest that the backchannel fosters engagement in the learning task and helps to overcome some of the obstacles associated with computer-mediated discourse by providing presenters with signals (or markers) which would allow presentation adjustment based on text-based cues from the learners. Also, the learner responses and discourse in the backchannel may enhance and shape the main channel message of the presentation while providing on-the-fly reflection which the instructor can monitor to check for learners' understanding and adjust the presentation based on the learners' responses. Further, the synchronous backchannel provides support for more immediate meaningful reflection and co-creation of knowledge amount learners.

Intrinsic Cognitive Load

Does learner communication within the backchannel also help presenters more effectively sequence and segment instruction? In turn, could these interactions be used to manage intrinsic cognitive load? Research suggests intrinsic cognitive load can be more effectively managed if content is presented in segments (Mayer & Moreno, 2003). In addition, research indicates that content sequencing is most effective when based on the learners' level of expertise and that the preplanning of content sequencing becomes less important if the sequencing can be continuously adapted during the instructional presentation based upon observation of the learners' expertise (van Merriënboer & Sweller, 2005).

Tied to the research discussed, it is possible that the backchannel provides presenters with signals or markers from the learner to gauge their level of understanding which would allow an adjustment to the presentation based on the cues from the learners. As noted, dialogue research suggests that speakers actively monitor their own speech and adjust their presentation based on their assessment of the listener's level of understanding (Clark & Krych, 2004). Listener backchannel responses, also referred to as project markers, play a role in shaping the presentation by providing the speaker with markers to chart progress and by signaling to the presenter that the listener is ready to transition with the presentation, including (a) acknowledgement tokens in which the listener acknowledges the presentation through utterances, such as "uh-huh", (b) agreement tokens in which the listener agrees with the presenter's position, such as "right", and (c) consent tokens in which the listener approves of the presenter's comments, such as "okay" (Bangerter & Clark, 2003). These project markers provide the primary speaker with marks to chart progress and signal to the presenter that the listener is ready to transition with the presentation. For example, the listener can offer the speaker (a) *continuers*, such as "yes", which signal the listener is ready to hear more, (b) *assessments*, such as reactions of "wow" or "gosh", which signal comprehension and evaluation of what has been said, or (c) *recipiency* markers which signal the listener wants to speak.

If backchannel interactions are considered signals from the learner as listener, it is possible that the presenter could monitor the learners' backchannel conversations to manage intrinsic cognitive load by assessing when the learners are ready to make transitions within the presentation. Cues from the learners' interactions in the backchannel may help the presenter to segment and sequence the presentation of content based on the learners' responses of either understanding or confusion thereby helping to manage intrinsic cognitive load. By monitoring the learners' public backchannel conversations and by assessing when the learners are ready to make transitions within the presentation, the presenter could use the backchannel interactions to overcome some of the obstacles associated with commuter-mediated discourse. However, monitoring the backchannel may increase the instructor's own cognitive load and disrupt the flow of the instruction when the instructor stops speaking to read the backchannel.

Summary

While no research has examined the influence of backchannel interactions in the computer-mediated classroom, findings in areas that share key features with this relatively new phenomenon may shed light on the effects the backchannel has on cognitive load. In evaluating research from laptop use during live face-to-face classes, CMC, and dialogue analysis, the findings seem to suggest support for *both* negative and positive effects on cognitive load. The potential for distraction and high interactivity may indicate backchannel interactions place unnecessary extraneous cognitive load on learners. However, findings may also suggest that the backchannel interactions directly facilitate learning through more effective processing of the to-be-learned material. Further, the signals and cues within the dialogue may help presenters to more effectively and efficiently sequence and transition within the presentation of content which may help to manage intrinsic cognitive load.

These findings have implications for instructional designers and suggest a range of research questions. Do backchannel interactions distract the learners from the task at hand and interfere with their receipt of the instructional message? Should backchannel interactions be used as a means of monitoring distance learners during instructional presentation? How can the synchronous backchannel provide support for immediate meaningful reflection and feedback?

References

Arbaugh, J. B. (2008). Does the Community of Inquiry Framework Predict Outcomes in Online MBA Courses? *The International Review of Research in Open and Distance Learning*, *9*(2). Retrieved from http://www.irrodl.org/index.php/irrodl/article/view/490

Bangerter, A., & Clark, H. H. (2003). Navigating joint projects with dialogue. *Cognitive Science*, *27*(2), 195. doi:10.1016/S0364-0213(02)00118-0

Barak, M., Lipson, A., & Lerman, S. (2006). Wireless Laptops as Means For Promoting Active Learning In Large Lecture Halls. *Journal of Research on Technology in Education*, *38*(3), 245-263.

Bavelas, J. B., Coates, L., & Johnson, T. (2000). Listeners as co-narrators. *Journal of Personality and Social Psychology*, *79*(6), 941-952.

Bower, M., & Hedberg, J. G. (2010). A quantitative multimodal discourse analysis of teaching and learning in a web-conferencing environment-The efficacy of student-centred learning designs. *Computers & Education*, *54*(2), 462–478.

Clark, H. H., & Krych, M. A. (2004). Speaking while monitoring addressees for understanding. *Journal of Memory and Language*, *50*(1), 62-81.

Cogdill, S., Fanderclai, T., Kilborn, J., & Williams, M. (2001). Backchannel: whispering in digital conversation (p. 8). Presented at the 34th Annual Hawaii International Conference on System Science, Maui, HI.

Coleman, L. H., Paternite, C. E., & Sherman, R. C. (1999). A reexamination of deindividuation in synchronous computer-mediated communication. *Computers in Human Behavior*, *15*, 51-65.

DeSanctis, G., & Monge, P. (1998). Communication Processes for Virtual Organizations.

Journal of Computer-Mediated Communication, *3*(4), 0-0. doi:10.1111/j.1083-6101.1998.tb00083.x

Fried, C. B. (2008). In-Class Laptop Use and Its Effects on Student Learning. *Computers & Education*, *50*(3), 906.

Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education*, *2*(2-3), 87-105.

Garrison, D. R., & Cleveland-Innes, M. (2005). Facilitating Cognitive Presence in Online Learning: Interaction is Not Enough. *American Journal of Distance Education*, *19*(3), 133.

Guess, A. (2008, April 18). Hey, You! Pay Attention! *Inside Higher Ed*. Retrieved June 17, 2008, from http://insidehighered.com/news/2008/04/18/laptops

Gunawardena, C. N., Lowe, C. A., & Anderson, T. (1997). Analysis of a Global Online Debate and the Development of an Interaction Analysis Model for Examining Social Construction of Knowledge in Computer Conferencing. *Journal of Educational Computing Research*, *17*(4), 397-431.

Havard, B., Jianxia Du, & Olinzock, A. (2005). Deep Learning: The Knowledge, Methods, and Cognition Process in Instructor-led Online Discussion. *Quarterly Review of Distance Education*, *6*(2), 125-135.

Kester, L., Kirschner, P. A., & van Merriënboer, J. J. (2006). Just-in-time information presentation: Improving learning a troubleshooting skill. *Contemporary Educational Psychology*, *31*(2), 167-185.

Lee, H., Plass, J. L., & Homer, B. D. (2006). Optimizing cognitive load for learning from computer-based science simulations. *Journal of Educational Psychology*, *98*(4), 902-913. doi:10.1037/0022-0663.98.4.902

Marshall, C. R., & Novick, D. G. (1995). Conversational effectiveness in multimedia communications. *Information Technology & People*, *8*(1), 54 - 79. doi:10.1108/09593849510081602

Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist*, *38*, 43-52.

van Merriënboer, J. J. G., & Sweller, J. (2005). Cognitive Load Theory and Complex Learning: Recent Developments and Future Directions. *Educational Psychology Review*, *17*(2), 147-177. doi:10.1007/s10648-005-3951-0

Moreno, R., & Mayer, R. E. (2007). Interactive multimodal learning environments. *Educational Psychology Review*, *19*(3), 309-326.

Paulus, T. M. (2007). CMC Modes for Learning Tasks at a Distance. *Journal of Computer-Mediated Communication*, *12*(4), 1322-1345. doi:10.1111/j.1083-6101.2007.00375.x

Pociask, F. D., & Morrison, G. R. (2004, October). *The Effects of Split-Attention and Redundancy on Cognitive Load When Learning Cognitive and Psychomotor Tasks*. Presented at the 27th Annual Association for Educational Communications and Technology, Chicago, IL.

Rourke, L., & Kanuka, H. (2009). Learning in Communities of Inquiry: A Review of the Literature. *The Journal of Distance Education*, *23*(1), 19-48.

Shannon, C. E., & Weaver, W. (1963). *The mathematical theory of communication*. Urbana, IL: University of Illinois Press.

Shea, P., & Bidjerano, T. (2009). Cognitive presence and online learner engagement: a cluster analysis of the community of inquiry framework. *Journal of Computing in Higher Education*, *21*(3), 199-217. doi:10.1007/s12528-009-9024-5

Sweller, J., & Chandler, P. (1994). Why Some Material Is Difficult to Learn. *Cognition & Instruction*, *12*(3), 185.

Winn, W. (2004). Cognitive perspectives in psychology. In D. Jonassen (Ed.), *Handbook of Research on Educational Communications and Technology* (Vol. 2, pp. 79-112). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

Yardi, S. (2006). *The role of the backchannel in collaborative learning environments*. Presented at the 7th International Society of the Learning Sciences, Bloomington, IN.

Yardi, S. (2008). Whispers in the Classroom. In T. McPherson (Ed.), *Digital Youth, Innovation, and the Unexpected*, The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning (pp. 143-164). Cambridge, MA: The MIT Press.