More is Less or Less is More:

The Impact of Cognitive Load on

Constructivist Distance Education Learning

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More is Less or Less is More: The Impact of

Abstract

This paper answers the research question, “What impact does cognitive load have on learning in distance education using constructivism?”, by examining what the educational research says about the cognitive load of learners in constructivist-based distance education and identifying strategies used to minimize cognitive load. The theme ‘More is Less or Less is More’ permeates the research with cognitive overload being caused by new technology, new learning environments, ambiguous or missing instructions, too many readings and/or external websites, large quantity and poor quality of discussions, and no relevant prior experience. To minimize the impact of cognitive load on constructivism, instructors should keep the user interface simple and visually clean, provide clear instructions including discussion expectations, limit readings and websites, participate in the discussion especially at the start, divide class into groups of 4-6, balance group experience across class, and provide scaffolding for novice learners.
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Introduction

“An instructional approach should be no more complicated than it needs to be. However, instruction must be as complicated as is necessary to achieve the established goals of learning, given the constraints imposed by the features of the knowledge domain that is the subject of learning” (Spiro, Feltovich, Jacobson, & Coulson, 1995, p. 106). Well-structured domains have an inherent structure, with material moving from simple to complex and a single or finite number of correct answers to any question. In a well-structured domain, such as mathematics, most learners would see true or false as the only valid answer to a question. Ill-structured domains can have some structure, but all topics are of equal importance and no single correct answer to any question. In an ill-structured domain, such as education, both true and false are valid answers to a question depending upon the world-view of the learner and as the perspective of the learner changes, the correct answer can change (true becomes false).

Similarly, distance-education methods depend upon the domain. Distance education in structured domains uses many of the direct instruction techniques (behaviorism/cognitivism, video lectures, interactive assignments) used in face-to-face (f2f) education. In ill-structured domains, constructivist distance education uses readings, open-ended questions, discussion via computer-mediated communications (CMC) (e-mail, bulletin boards, list-servs) and reports and/or relevant projects. Learners use cognitively-oriented constructivism as they work through the readings and answer questions, and socially-oriented constructivism as learners challenge, discuss and seek consensus.

Cognitivists believe that knowledge can be transferred to the learner and seek the most efficient method for learning. Constructivists believe that knowledge cannot be transferred, but must be constructed by the learner from their own experiences. Both cognitivism and
Piaget (1992) examined how young learners construct knowledge. He felt there were three methods to achieve equilibrium between their understanding and the world: learners assimilate new knowledge by adapting long-term memories and accommodate long-term memories to adapt to new knowledge; learners resolve conflicts within classes of memories; and disequilibrium forces construction of a new equilibrium, which does not lead back to the previous equilibrium. Learners incorporate new knowledge into long-term memories (schema) or change schema to deal with new knowledge. Learners resolve issues between related schema and new knowledge. Over time, learners create new schema, which better explains their understanding of the world. Cognitivists seek the most efficient method to get new knowledge into the schema of learners, while cognitive-oriented constructivism uses exploration and discovery to allow learners to construct new knowledge into their schema.

Vygotsky (1978) studied the relationship between learning and development in children, with emphasis on language and play. He believed that “learning awakens a variety of internal processes that are able to operate only when the child is interacting with people in his environment and in cooperation with his peers” (p. 90). He felt these ‘zones of proximal development’ must be internalized to become part of the child’s independent developmental achievement. Vygotsky contends that the developmental process lags behind the learning process and although learning is directly related to development, the two are not equal or parallel. He illustrates the internalization process as a series of transformations, where external activity is reconstructed and begins to occur internally, interpersonal (social) process is transformed into an intrapersonal (personal) process, and the transformation of a social process
into a personal process is the result of a long series of developmental events (pp. 56-57).

Learners learn through interactions with others with more experience, but the learning must be internalized by the learner to become development. Cognitivists function as experts structuring information for learning, while socially-oriented constructivism uses discussion among learners to challenge the understanding of each individual to correct misconceptions.

Cognitivists put scaffolding in place to minimize extraneous information, parcelling knowledge into chunks for efficient acquisition by learners. Constructivists use real world tasks with minimal guidance. This is the dilemma: cognitivism as a teaching theory works within constructivism as a learning theory, but constructivism as a teaching theory violates cognitivism as a learning theory. Kirschner, Sweller, and Clark (2006) feel that constructivism causes cognitive overload in novice learners as the search for answers, with minimal guidance, forces learners to overload their working memory with little transfer to long-term memory and creating weak problem-solving skills. For the novice, everything is new, so everything is important; this leads to cognitive overload. The learner may make sense out of one report, but what do they retain after weeks of processing reports and answering questions or dealing with multiple distance education courses.

The purpose of this paper is to answer the research question “What impact does cognitive load have on learning in distance education using constructivism?”, to determine what the educational research says about the cognitive load of learners in constructivist-based distance education and to identify strategies used to minimize cognitive load.

**Constructivism**

Doolittle and Hicks (2003) feel constructivism is based upon the following premises: learning is individual and social; learning depends on the individual and social context of the
learning environment; learning uses authentic and real-world learning tasks; learning requires prior knowledge and experience; learning requires multiple examples using different methods for different learning styles; learners must become lifelong learners; and teachers are ‘guides at the side’ facilitating knowledge construction, not ‘sages on the stage’ dispensing knowledge. Rovai (2004) believes constructivist learning environments use curriculum customized to students’ prior knowledge, teaching strategies tailored to students, and open-ended questions to promote extensive dialogue between learners. He feels these components are reflected in the important elements of online courses: presentation of content - course materials in an integrated, intuitive manner for access at any time; instructor-student and student-student interactions - discussion topics and discussion forums for consistent interaction between students, and instructor and students, and student summaries of discussions; individual and group activities - balance of individual and group work, and class-wide and group discussions; and assessment of student performance - diverse and authentic assessments, with graded participation, assignment receipt acknowledgements, detailed and timely feedback, and opportunities for reflection.

**Cognitive Load Theory**

Building on the work of theorists, like Piaget and Vygotsky, cognitivists study how the brain learns. Cook and McDonald (2008) feel cognitivism is based upon the idea that learning requires integration with prior knowledge and experiences, learning depends on the context in which it takes place, learning requires application to a new situation (far transfer), and mental load during learning should be controlled (Cognitive Load Theory). Van Merriënboer and Sweller (2005) believe working memory is limited to seven unique pieces of information, with operation on two to four pieces at a time, held for 20 seconds unless refreshed by rehearsal. They feel working memory must be transferred to schema or lost. Working memory is severely
limited in capacity during learning (transfer from working memory to schema), but largely
unlimited during recall (transfer from schema to working memory) (Kirschner, Sweller, & Clark,
cognitive load, the effort required to transfer knowledge from working memory to schema, is
fixed and cannot be reduced. He feels extraneous cognitive load is instructional information,
which is not needed and overloads working memory, and germane cognitive load is additional
load over intrinsic cognitive load to maximize learning. Regardless of the source (intrinsic or
extraneous), Sweller believes learning will be difficult if cognitive load is high, so the purpose of
instruction is to minimize extraneous cognitive load, while maximizing germane cognitive load.
Sweller proposed Cognitive Load Theory for designing instruction to reduce extraneous or
unnecessary cognitive load while increasing germane or necessary cognitive load.

Van Merriënboer and Sweller (2005) summarize Cognitive Load Theory’s ways to
reduce cognitive load by use of the following effects: goal-free effect - focus on learning, not
answers to specific problems; worked example effect - provide full solutions to focus on problem
and possible solution states; completion problem effect - provide partial solutions to focus on
problem and possible solution states; split attention effect - use a single cohesive learning
resource; modality effect - use multimedia to use visual and auditory processing of working
memory; and redundancy effect - remove redundant information from instruction. They state
Cognitive Load Theory’s ways to maximize learning are: germane cognitive load; expertise
reversal effect - novice instructional methods do not work on experts; and adaptive eLearning -
instruction cannot be created to take into account the expertise of each individual, which requires
learner pre-assessment and unique evaluations. From the perspective of Cognitive Load Theory,
a constructivist learning environment would increase the extraneous cognitive load on learners.
Information Overload

Information overload can come from a combination of technology, learning environment, instructions, readings, external websites, discussions, and experience. Chen (2009) states “cognitive overload is the load imposed on students during content learning”, while information overload “is the “noise” preventing students from learning content” (pp. 112-113). She feels information overload is “the point at which a learner’s capacity of working memory is exceeded, and the excessive information and stimuli from the CMC learning environment interfere with content learning” (p. 113). Paulo (1999) studied students using f2f classes and CMC discussion and despite the perceptions of learners that there was more information in the CMC component, she concludes that there was actually less information and learners were not suffering from information overload, but stimulus overload. She hypothesizes that “[t]hinking of information overload in terms of the absolute amount of information is too simplistic” (p. 50). It is not a single item, but the total impact of the constructivist distance education course, which causes cognitive overload. Learners are bombarded with too much information to process!

Technology and Learning Environment

Students had difficulties with learning how to use the learning environment (Harasim, 1987). Chen (2003); Hara and Kling (1999); Murphy and Coleman (2004); Paulo (1999); Varnhagen, Wilson, Krupa, Kasprzak, and Hunting (2005); and Wu and Hiltz (2004) learned that students were frustrated due to technological problems. Online participation is influenced by technology and prior usage of CMC is beneficial to learners (Vonderwell & Zachariah, 2005). Students had interaction problems with CMC due to their lack of technical expertise or their being unwilling to adapt to an unfamiliar system (Ferguson, 2010).

High cognitive load is expected as learners learn how to use technology or the learning
environment, but this load should decrease as learners become comfortable throughout the course. Harasim (1987) stated information overload was stronger at the start of the course as students adjusted to a new learning environment. Instructional designers should keep the learning environment as simple and visually clean as possible to minimize cognitive load.

**Instructions**

Some studies (Hara & Kling, 1999; Mason & Weller, 2000; Qui, 2010; Varnhagen et al., 2005) report distance education students were frustrated by ambiguous or non-existing directions. Varnhagen et al. (2005) learned “[s]tudents felt that a contributing factor to some of the difficulties experienced with learning this type of course content online was the lack of clear course expectations” (p. 14). In an analysis of the course instructions, Hara and Kling (1999) found that although the instructor wanted to allow flexibility for the learners, the instructions were too simple and could be interpreted in different ways, which they theorize might have increased students’ anxiety. Although a certain amount of cognitive load is expected as learners seek to understand learning tasks, ambiguous or non-existing directions and errors can cause increased cognitive load, which has to be sorted out on the discussion boards.

**Readings and External Websites**

Some studies (Chen, 2003, 2009; Hara & Kling, 1999; Harasim, 1987; Vonderwell & Zachariah, 2005) found learners had concerns with the amount or quality of course readings and third-party reference websites. Students, overwhelmed with readings and workload, attempted to negotiate with the instructor to decrease the number of assignments and discussions (Vonderwell & Zachariah, 2005). In a quality survey for distance education, students showed frustration with outdated readings and broken links (Weaver, Nair, & Spratt, 2005).

All information the learners must process (instructions, readings, websites, discussions)
is text, so large volumes of text can cause cognitive overload in learners. In addition, learners may have to read the same academic reading a number of times to achieve understanding. Instructors must realize that f2f courses do not directly translate into constructivist courses. The more readings the learner has to process, the less they learn, so it is better to have fewer readings to allow learners to get more out of each reading.

**Experience**

A number of studies (Chen, 2003, 2009; Du, Zhang, Olinzock, & Adams, 2008; Eryilmaz, Alrushiedat, Kasemvilas, Mary, & Pol, 2009; Farouck, 2010; Golanics, & Nussbaum, 2007; Hendriks & Maor, 2001; Mason & Weller, 2000; Varnhagen et al., 2005; and Vonderwell & Zachariah, 2005) discovered learners had problems due to lack of relevant prior knowledge. “The importance of students’ prior experiences establish their starting point with regards to their learning” (Hendriks & Maor, 2001, p. 734).

Some learners prepare for online discussions by arming themselves with previous discussions, textbooks, or websites (Du et al., 2008). These learners increase their cognitive load to meet the learning task. Some learners with high perceived information overload were able to process information at a deep level because they perceived the difficulties of learning using CMC, while others were unable to process information at a deep level due to lack of prior subject knowledge and computer competence (Chen, 2003, 2009). Good students will succeed regardless of the learning environment, but relevant prior knowledge is essential.

Both constructivism and cognitivism assume prior knowledge, but cognitivism’s assumption of a lower level of knowledge is better positioned to facilitate learning if relevant prior knowledge is low. Relevant experience means less cognitive load on the learner, while less relevant experience means a heavier cognitive load on novices. If everything is new, the novice
will struggle to find meaning because they have no schema in place.

Discussions

**Quantity vs Quality.**

A number of studies (Angeli, Valanides, & Bonk, 2003; Chen, 2003, 2009; Dooley & Wickersham, 2007; Ferguson, 2010; Golanics & Nussbaum, 2007; Hara & Kling, 1999; Harasim, 1987; Hatch, 2002; Jorczak, 2009; Ke & Xie, 2009; Mason & Weller, 2000; Murphy & Coleman, 2004; Yeh & Lahman, 2009) found CMC had a large quantity of discussion and/or a low quality of or irrelevant discussion. The quality of online discussions in a hybrid course (f2f and distance) was low with replies consisting of 35% social acknowledgement and general feedback, 9% clarification or prompts for further dialogue, 49% unsupported advice and personal opinions, and just 7% justified opinions and claims (Angeli et al., 2003). In another study, Dooley and Wickersham (2007) observed 34% of CMC discussion was off-topic. In a study of six courses, Hatch (2002) discovered the following discussion board usage: 3 students no usage; 8% - 2 or 3 times total; 32% - once a week or less; 38% - 3 times per week; and 19% - at least every weekday. He feels the low usage was due to the large volume of postings from the large class size and to irrelevant postings.

Also, graduate students were overwhelmed by the quantity of emails, competed to produce a volume of messages, did not participate in discussion, and replied without reading contents (Hara & Kling, 1999). Graduate students created low quality and high quantities of postings to meet grade requirements, which affected the purpose and quality of discussion (Murphy & Coleman, 2004). Adult students had high satisfaction for online learning and reported a deep dominant learning approach (synthesizing ideas, knowledge application, self-reflection), but content analysis showed mostly surface, individualistic knowledge construction.
As the quantity of discussion increases, the quality of discussion decreases. Learners use their long-term memories to decrease their cognitive overload, regardless of relevancy.

**Learner Strategies.**

Some studies (Harasim, 1987; Hewitt & Brett, 2007; Peters & Hewitt 2010; Qui, 2010) document strategies learners use to deal with information overload caused by discussions. Harasim (1987) learned students developed individual (selective reading and commenting; and scanning messages) and social (encouraging shorter messages) strategies. Peters and Hewitt (2010) found learner strategies were to participate frequently, skim messages, focus on a single thread, and read messages selectively. Qui (2010) reports learners strategies as selective reading (by topic or author), scanning quickly, skimming messages, skipping reading some completely, or ignoring large numbers of messages. Hewitt and Brett (2007) analysed 28 CMC courses for class size and online activity patterns. They observed that larger classes write more shorter notes than small classes while larger classes opened fewer notes, and as message size increased, large classes tend to skim or scan messages more frequently than small classes.

Jones, Ravid, and Rafaeli (2004) analysed 2.65 million postings to 600 Usenet newsgroups over a 6-month period and found users had individual strategies for coping with information overload which included: more likely to respond to simpler messages when overloaded; more likely to end active participation as overloading increases; and more likely to generate simpler responses as the overloading grows. This behaviour can be explained by Cognitive Load Theory (recall is unlimited and fast; learning is limited and slow). As cognitive load increases, users process simpler messages easier than complex messages. But if cognitive load gets too large, users cannot process the information, so they stop participating. Finally,
users are scanning messages looking for something about which they have prior knowledge, enabling them to easily process and post a simple reply with little mental investment.

This is the same methodology learners use to participate in online discussions. Learners are forced to participate and to post quality over quantity. As cognitive load increases, learners scan discussions for relevant prior knowledge. They process the messages on a surface level, looking for phrases they recognize. Once they find a phrase, they post a simple reply or a large message, which they consider to be their contribution to the discussions. It is irrelevant to them that their posting had very little to do with the discussion. They completed their part with very little mental investment. Learners do not understand the constructivist process. They do not question or challenge because then someone may question or challenge them. If they see a large message, the easiest response is “I agree”, but what are they actually agreeing to? As Kirschner et al. (2006) state:

The aim of all instruction is to alter long-term memory. If nothing has been changed in long-term memory, nothing has been learned. Any instructional recommendation that does not or cannot specify what has been changed in long-term memory, or that does not increase the efficiency with which relevant information is stored in or retrieved from long-term memory, is likely to be ineffective. (p. 77)

Computer Mediated Communications.

In a study to see why threads die in CMC, Hewit (2005) determined that learners use a single-pass methodology where they read unread threads and construct responses to some of these threads to meet participation requirements, while leaving important threads to die. He feels the contents of these messages drive the discussion, not the course requirements and learners can be seen to be deeply engaged in peer interaction without heavy mental investment. He believes learners’ single-pass methodology is due to: attraction to unread flags while unintentionally neglecting important discussions; learners may not engage in synthesis and summarizing
operations because they may have to revisit previous threads; deal with off topic postings; and difficult issues may be neglected due to learners gravitating to familiar, comfortable topics. The learning environment acts to kill quality discussion because the attention of learners is attracted to unread postings, regardless of quality. The easiest way to deal with discussion, from a cognitive load perspective, is to process unread topics without heavy mental investment.

The asynchronous nature of CMC increases the cognitive load on learners. Although there are benefits to asynchronous discussion, threaded CMC messages are not true discussion. Asynchronous CMC discussion creates redundant information and causes fragmentation of information due to the non-linear format (Chen, 2003). Qui (2008a) reports large classes had too many threads branching out that were difficult to follow. Peters and Hewitt (2010) found learners had difficulty synthesizing discussion material due to the large number of threads and the way they were organized. Delayed responses affected quality of discussion (Hara & Kling, 1999) and caused frustration in receiving feedback and ‘out of sync’ communications between part-time weekend and full-time weekday students (Harasim, 1987).

**Learning Environment Strategies**

Learning environment strategies attempt to change the learning environment to minimize cognitive load. The drawback is that these strategies do not address the two uncontrollable sources of cognitive overload: lack of prior knowledge and discussion volume.

**Printed Online Materials**

Students preferred materials with convenient (Adobe pdf) print form (Hatch, 2002). In a study to see if printed materials usage would reduce cognitive overload, learners did use printed materials to reduce extraneous cognitive load, but the higher scores went to computer-screen preference learners over printed-paper or no-preference learners (Chang & Ley, 2006).
Although printed materials have benefits (mark-up materials, notes; anywhere, any time reading, free from computer), cognitive load is increased as the learner must keep track of the materials.

**Question Elaboration and Goal Instructions**

Golanics and Nussbaum (2007) found positive results for high knowledge learners for collaborative argumentation using question elaboration and goal instructions, but the sheer volume of notes caused cognitive overload for low knowledge learners. Deeper thought requires prior knowledge. Learners without a schema will experience cognitive overload as they attempt to form an opinion about something that is new to them.

**Role Based Discussion**

Kanuka, Rourke, and Laflamme (2007) studied the quality of students’ contributions to online discussion in five different activities: the nominal group technique, debate, invited expert, WebQuest and reflective deliberation. Although they found the cognitive presence to be low (the proportion and number of contributions), the highest (20.21%) occurred during the WebQuest and debate activities because they were well structured with clearly defined roles and responsibilities, and they provoked students to explicitly confront others’ opinions. Giving discussion roles to learners may marginally decrease cognitive load as they process information to fulfill their roles, in a very weak form of guidance.

** Anchored Discussion**

Eryilmaz et al. (2009) studied the effect anchored discussion, placing discussions near the topic being discussed to make the connection between them explicit, has on reducing cognitive load. Their results were positive with learners “who perceive selected online discussion articles challenging, but not too difficult to give up collaborative knowledge construction in frustration” and they “reported more mental effort and performance with the adopted tool” (p. 8). Anchoring
discussion or providing different boards for each reading may marginally decrease cognitive load due to framing the discussion.

**Enhanced Computer Mediated Communications**

Kear and Heap (2007) implemented enhanced CMC to decrease information overload, which consisted of branched message threads with title revision, the ability to recommend messages, the ability to filter messages (recommended, unread, recent or all); and a personal ‘clippings’ area for book-marking useful messages. They observed that perceptions of overload decreased after the modifications, but although some learners thought the modifications were useful, actual usage was low. Enhanced CMC will not decrease overload because the number of messages will not decrease. Learners’ cognitive load controls how they process messages.

**Instructor Strategies**

**Presence**

One aspect that has a significant effect on helping learners deal with cognitive load is the presence of an expert - the ‘guide at the side’. Providing just-in-time feedback, especially at the start of the course, will allow many learners to develop confidence in their answers and discussions. The instructor or tutors may have their own possible cognitive overload, but unlike the learners, they can use their existing schema to efficiently guide learners along the desired path. The constructivist process is harder on the learner, but sometimes all the learner needs is to know that they are going in the right (or wrong) direction. This will not eliminate cognitive load but will minimize negative effects.

Students were frustrated by minimal and slow feedback (Hara & Kling, 1999). Learners preferred consistent communications and feedback with the instructor, but response time and grading slowed at the end of the course (Vonderwell, 2003). Learners wanted more feedback
and greater instructor presence (Wu & Hiltz, 2004). Learners appreciated high instructor presence, but wanted more feedback (Varnhagen et al., 2005). Qui (2010) reports learners in a small class became frustrated when the instructor did not participate for a ‘prolonged period’. Gorsky and Blau (2009) found high teaching presence created a significant relationship between social presence, and students’ active/passive participation and satisfaction and that frequent instructor responses correlated with students’ active/passive participation. A well-structured domain course had higher amounts and proportions of teaching, social and cognitive presence than an ill-structured domain course (Gorsky, Caspi, Antonovsky, Blau, & Mansur, 2010).

Packham, Jones, Thomas, and Miller (2006) studied the perceptions of students and tutors on effective e-moderation. They found students’ key attributes were the quality of feedback, student support and module management, while tutors felt that motivating students, constructive feedback and an engaging on-line persona were critical. They felt both groups were similar and the difference dealt with how each interacts with the learning environment.

**Expectations**

Missing or unclear expectations on the quantity and/or quality of discussion will only increase the quantity without insuring quality. Learners were frustrated by being forced to use, without direction and purpose, CMC discussion to receive marks (Murphy & Coleman, 2004). Learners wanted clear rules for discussion (Wu & Hiltz, 2004). Peters and Hewitt (2010) found completely different expectations for six different courses, ranging from “[s]tudents should be active in the discussions every week”; to “[s]tudents should write [at] least two or three messages each week”, “[s]tudents should write substantive messages” and “[p]articipation will be assessed by both the quality and quantity of your weekly contributions to the class” (p. 953). It is understandable why a large quantity and poor quality discussion would result from these
instructions. Orientation sessions were useful for learners to understand course requirements and instructors’ expectations (Chen, 2003). Yeh and Lahman (2007) state instructors should “offer clear guidelines and rules of posting messages, replying to messages, length of messages, and the deadline of each discussion forum” (p. 698).

In addition, many learners do not understand the purpose of discussion in the constructivist learning process. In a study using f2f and CMC discussions, Ellis and Calvo (2006) report only a small number of learners were comfortable with learning through discussions where learners had poor approaches to discussions, discussion workload issues, and a lack of awareness of the value of discussion for learning. Khine, Yeap, and Chin Lok (2003) report that learners did not participate or interact, no discussion lead to mostly dead threads, learners preferred information acquisition with no constructivism, and an absence of questioning. Even when the environment was altered they found learners “still resisted tasks that demanded thinking, independent and deep thinking, interaction and participation” (p. 122).

Chen (2003, 2009) feels that the amount of invested mental effort for learning forced learners with low perceived information overload to process information at a surface level when they found it easy to operate and learn in the online environment, to tend to post superficial messages, and to not invest much mental effort into study. “Students with low perceived self-efficacy will not put much effort into study when they perceived the demands of the medium to be high” (Chen, 2009, p. 114). Conceptual change occurs when learners are confronted with information that contradicts their conceptualizations (Jonassen, 2006). Jonassen (2006) feels that low-domain-knowledge learners will not notice the contradictions, low-interest learners are unlikely to engage in conceptual change, and experts are unwilling to change. Novice or low-motivation learners miss the relevance of the discussion in constructivist learning environments,
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so they complete the learning tasks with little mental investment or interaction with others.

Clear expectations would decrease cognitive load in two ways: decrease overall messages; and allow learners to reply to one or two messages a week, which would let them have more time to understand others and should produce better quality, more interactive discussions.

Groups

One way to decrease the number of discussion messages learners must process is to split the class into groups. This means that learners will have less cognitive load and possibly produce better quality discussions.

Size.

Hatch (2002) found in a study of six courses that discussion boards should be limited in size by using groups or creating specific forms. Students preferred small efficient groups of three to four (due to getting acquainted, feeling more at ease, more opportunity to express their ideas and opinions on a more equal level) (Du et al., 2008). Instructors disagreed on optimal group size, ranging from 5-7 to 4-10, with an average of 6 (Yeh & Lahman, 2009). The quality of discussion in smaller groups (8-10 learners) had larger proportions of higher levels of knowledge construction than average (11-13) or large (15-18) groups; groups were in general very task oriented (Schellens & Valcke, 2006).

Qui (2007, 2008a, 2008b, 2010) conducted a number of studies on class size, group size and workloads in CMC courses. She found that: large classes with subgroups produced more threads with more opportunity to start threads than large whole or small whole classes (Qui, 2007); small whole class had a small number of threads and limited topics which discouraged learners (Qui, 2008a); students in small groups read the least percentage of notes but write the most total notes; students in groups and large classes can write and read more notes than small
classes; instructors wrote less in group mode; group does not increase instructor workload but
class size does; instructors and students should take advantage of small class size to read more
notes and write better quality notes (Qui, 2008b); and all three sizes (large, groups, small) have
advantages and disadvantages, but group discussion is the best balance (Qui, 2010). Qui (2010)
believes “the ideal class size or group size is one that serves the purpose of supporting individual
learning” (p. 178) and “splitting classes into subgroups serves as a strategy to reduce information
overload and to encourage focused, in-depth small group discussions” (p. 185).

Group size is an important component in decreasing cognitive load since learners have to
process a smaller number of messages. The quality of discussions should be better as each
learner has a greater opportunity to construct knowledge.

**Composition.**

Individuals with experience can steer novices (Vonderwell & Zachariah, 2005). Farouck
(2010) studied the collaborative learning among experienced, average and novice learners, and
determined that all learners have a comfort level to sustain effective collaborative learning and
knowledge construction, where experienced learners drop out when the content was too easy and
novice learners drop out when too hard. They conclude that effective collaborative work should
consider factors such as knowledge gap, personality and environmental factors, and content
difficulty level. By distributing the experience pool across the groups and designing learning
tasks that will interest all group members, the cognitive load on each individual will decrease as
each member finds a role they are comfortable with and experienced learners can help novices.

**Discussion**

Very few of the studies (Chang & Ley, 2006; Chen, 2003; Eryilmaz et al, 2009; Golanics
& Nussbaum, 2007; Vonderwell & Zachariah, 2005) discuss cognitive load, preferring the
neutral term ‘information overload’, but it is clear that cognitive load has a major negative impact on constructivist instruction. The two main areas that cause cognitive load are lack of prior knowledge and discussion size. It is important that constructivist-based learning be structured to minimize the cognitive load of learners.

It is quite clear from the research that students and instructors do not understand constructivism. “An online course that consists of only textbook reading assignments, a syllabus with course schedule, online discussions, and assessments is tantamount to taking a traditional course and pedagogically reengineering it by removing all instructor classroom presentations and offering no replacement” (Rovai, 2004, p. 84). The instructor has to create an environment that will meet the needs of learners with diverse prior-knowledge levels and different learning styles. The instructor must participate in the learning process. Simple messages like “Good discussion” or “Good summary” and redirected questions, go a long way to provide guidance for learners without negative effects on constructivist discussion.

The theme ‘More is Less or Less is More’ permeates the research. All the information, the learner must process is text. Too many readings or external websites cause learners to achieve less due to cognitive overload, while fewer readings allow learners to get more out of each reading. The more experience, the less cognitive load, while the less experience, the more cognitive overload. Novices get little out of constructivist learning because of a lack of prior knowledge. The more individuals in the discussion and the more average discussion text size, the less the quality of the discussion due to cognitive overload. The smaller the discussion group, the better the discussion, which means large class sizes should be broken into 4-6 person groups. This allows each individual to process what the other group members have to say and get more out of less discussion. The greater the instructor presence, the less anxiety, and the
greater active/passive participation and satisfaction. The less presence, the more anxiety. The more ambiguous the discussion expectations, the less quality, the more quantity, and a greater cognitive load. Better expectations should produce fewer, but better quality discussions.

**Conclusion**

Cognitive load seems almost too simple an answer to explain the primary research into constructivism using open-ended questions and discussion, but sometimes the simplest answer is the best. Spiro and Deschryver (2009) believe direct instruction does not apply to ill-structured domains and the only method is some form of constructivism, regardless of what the primary research shows. But without the primary research to prove constructivism is better, all they have is an opinion. Constructivists may disagree with cognitivists on learning but the constructivist that does not take cognitive load into account does not understand constructivism!

To minimize the impact of cognitive load on constructivism, instructors should keep the user interface simple and visually clean, provide clear instructions including discussion expectations, limit readings and websites, participate in the discussion especially at the start, divide class into groups of 4-6, balance group experience across class, and provide scaffolding for novice learners.

The existing research supports the position of Kirschner, Sweller, and Clark. Cognitive load has a major negative impact on the quality of discussion. If the quality of discussion is poor or missing, does socially-oriented constructivism exist? If socially-oriented constructivism does not exist, can constructivism work? Learners are left with cognitively-oriented constructivism and novice learners, with little prior knowledge and minimal guidance, must struggle to find meaning when everything is new. It is clear that this issue requires further study, but as demonstrated by the attitudes of Spiro and Deschryver (2009), would constructivists even care?
References


