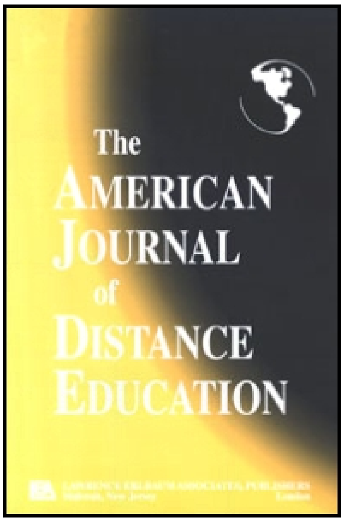


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# Using Cognitive Load to Evaluate Participation and Design of an Asynchronous Course

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# Using Cognitive Load to Evaluate Participation and Design of an Asynchronous Course

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**Abstract:** This study examined the effects of cognitive load experienced by e-learners as they negotiated the tasks required for successful participation within an asynchronous course room, specifically examining the relationship between measured cognitive load and the learners' confidence in completing their course. The results indicated that learner confidence, or more specifically self-efficacy, is the single most important factor in determining the success of e-learners. It appears that insufficient time was expended orienting learners to the virtual classrooms and to the technology necessary for participation.

The advent of e-learning occurred as society progressed from one based upon industry to one based upon information. This societal change has heralded many technological revolutions and has advanced the global economy and marketplace. Rosenberg (2001) explains that corporations and agencies must train their workforce to keep pace with ongoing technological changes, thereby remaining competitive within the global market. According to Hiemstra (2002), this societal change has required educators to design interventions that are timely, cost-efficient, and strategically focused.

The mental demands of learning have been a subject of considerable study for many decades. Cognitive load theory has emerged to become a major theory providing a framework for conducting research into learners' cognitive process and influence of instructional design (Paas, Renkl, and Sweller 2003). According to Paas, Tuovinen, et al. (2003) cognitive load theory is defined as being "concerned with the development of instructional methods that efficiently use people's limited cognitive processing capacity to stimulate their ability to apply acquired knowledge and skills to new situations" (63).

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Cognitive load theory stipulates that all new learning must utilize working memory, which is a limited resource (Sweller 1988).

Learning complex material requires the construction of mental models known as schemas. As learning progresses, new information is organized or incorporated into new or existing mental models (Sweller 1999). An important concept in managing a learner's mental workload is estimating the learner's existing knowledge base. Learning new material is more demanding than building upon existing mental schemas (Paas 1992). The demands of learning new materials or skills can easily overload a learner's limited capacity of working memory, whereas prior knowledge is recalled using minimal cognitive resources (van Merriënboer and Sweller 2005). A learner, especially an inexperienced learner, must simultaneously contend with multiple cognitive demands imposed by an asynchronous course.

Studies have revealed that the demands of cognitive load are additive, varying considerably throughout an instructional event (Paas, Tuovinen, et al. 2003). In the online environment, learners reach a state of cognitive overload when the demands of e-learning exceed their existing working memory capacity or if noninstructional ancillary demands on the learner are high. The effects of cognitive overload manifest in the learner as frustration, anxiousness, or loss of confidence in one's ability to complete the course or assignment (Paas, Renkl, and Sweller 2003; van Merriënboer and Sweller 2005). The experience of cognitive overload results in a sense of frustration or failure. Instructional designers and faculty must understand the e-learner's perceptions of their online experience. This understanding is the first step toward developing strategies to compensate and assist students to become successful e-learners.



## THE TYPICAL LEARNING TASKS OF E-LEARNERS

Tyler-Smith (2006) conducted research on the participation demands experienced by novice asynchronous learners, and he proposed a theoretical model that identified the typical learning tasks that an e-learner must contend with immediately and simultaneously upon beginning an asynchronous course. These tasks are (a) negotiating the technology, (b) negotiating the course Web site, (c) negotiating the course content, (d) becoming an e-learner, and (e) negotiating computer-mediated communication (CMC) interaction. The tasks, as defined, describe the skills or knowledge required for participation in the majority of online course rooms.

Learners must adapt to the online environment before meaningful learning can occur; therefore, understanding the cognitive load resulting from each task, including the learners' perception of their ability to complete the course, will be valuable in the creation of improved instructional strategies, designs, and participant selection procedures (Clark 2003). The topic of this study is an analysis of the effects of cognitive load experienced by e-learners as they negotiate the tasks required for successful participation within an asynchronous course room.

Placing e-learners into an unfamiliar, online learning role that requires them to actively participate in the online communications and integrate challenging course content could effectively overwhelm and frustrate learners, causing them to disengage or fail to learn from the online experience. Identifying the causes of excessive cognitive load provides opportunities for instructional designers and content administrators to improve instructional designs and procedures or to add additional orientation activities that could mitigate some of the demands being experience by e-learners:

> The one area where something may be done to reduce attrition is in the early stages of an online course. Cognitive overload is a likely contributor to high drop out rates, particularly where those withdrawing do so within the first few weeks of the start of a course. Greater levels of persistence and completions may be achieved if learners are supported to anticipate, prepare for, [sic] recognise and recover from the cognitive burden they may experience as first time e-learners. (Tyler-Smith 2006, 82)



## COGNITIVE LOAD THEORY

Cognitive load theory is most often associated with the design and development of instructional materials and their regulation or flow of new information into the learner's working memory. This study was focused on measuring the cognitive demands experienced by e-learners and their perceptions concerning completing the asynchronous course (Sweller 1988; Tyler-Smith 2006; van Merriënboer and Sweller 2005). The works of researchers in the area of cognitive science have significantly influenced the design of instructional content for use within the Web environment, specifically e-learning. Sweller (1999), referring not just to e-learning but also to all instructional design, comments that "traditional instructional designs are just that: traditional. They tend to be governed by nothing more than tradition and intuition" (2). Sweller is referring to instructional designs and the designers who do not avail themselves of current research and theory about human cognition and methods to control cognitive load. Sweller (1988) makes it very clear that the human intellect has limitations as well as strengths; the limitation of the human intellect, specifically the attention span, is the attribute making instructional design so very important.

Responsibility lies with practitioners and instructional designers to take advantage of discoveries in the areas of cognitive science and strategically designed content that enhances retention and practical recall of necessary knowledge, skills, and abilities (Sweller 1999). The cognitive load theory body of knowledge has continued to grow during the past three decades. The body of knowledge continues to be refined and updated, reflecting both the technological innovations and the results of many years of cognitive load research. Paas, Renkl, and Sweller (2003) changed the fundamental understanding of cognitive load theory by proposing that the concept requires further refinement, suggesting a categorical separation differentiating the three types of cognitive load: intrinsic, germane, and extraneous.

Sweller (1994) defined intrinsic cognitive load as mental exertion determined by the interactivity or difficulty of the instructional materials and the expertise of the learner. Germane cognitive load relates to the process of forming mental modules, schemas, and automation, whereas the term *extraneous cognitive load* refers to the unnecessary load caused by poor content design or facilitation (Paas 1992). According to Morrison and Anglin (2005), early cognitive load research had shortcomings because focus was primarily on reducing or controlling only extraneous load in an effort to ensure sufficient mental resources remained for the construction of knowledge.

Controlling the accumulated cognitive load experienced by a learner while preventing overload is a daunting task because each learner has varying prior knowledge. A goal of cognitive load theory is to inform instructional designers about the development of content that will permit learners sufficient cognitive resources to build schemata. Current studies also recognize the importance of controlling both intrinsic and germane loads. Reduction of the extraneous load can be wasted effort depending on the level of element interactivity of the content and the relative expertise of the learner (Paas, Renkl, and Sweller 2004). According to Renkl and Atkinson (2003), as the learner progresses through instructional content and learns the material, the intrinsic load gradually reduces.



## Cognitive Workload Measurement

The issue of measuring cognitive load has proven to be a challenge for researchers. There are currently four accepted approaches or techniques employed: physiological measures, subjective measures, secondary task measures, and primary task measures (Brunken, Plass, and Leutner 2003; Zhang and Luximon 2005). The majority of the measurement methods is objective in nature and requires a controlled environment or laboratory to conduct. In physiological measure the researcher would directly monitor the respondent's signals like eye dilatation, heart rate, or body temperature to evaluate task difficulty. Likewise, secondary and primary task measures are performed in a controlled environment and involve the respondent performing simultaneous task or tasks with a researcher documenting the response times. From a practical point of view, the subjective or self-report approach is the only current option to measure cognitive load in a field-based study. See Figure 1.

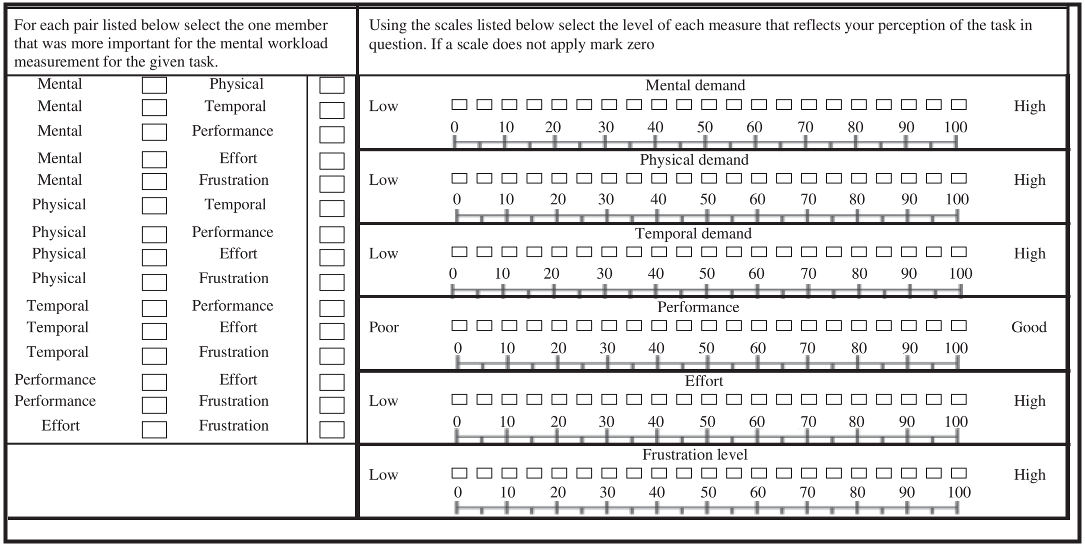


***Figure 1.*** NASA-TLX. *Note:* Adapted from *Development of the NASA-TLX Index: Results of Empirical and Theoretical Research,* by S. G. Hart and L. E. Staveland, 1988, Human Mental Workload, Amsterdam, the Netherlands: North-Holland Press. No copyright; publicly accessible from http://ntrs.nasa.gov/search.jsp? R=23637 &id=1&qs=Ntt%3DNASA-TLX%26Ntk%3Dall%26Ntx%3Dmode%2Bmatchall %26Ns%3DArchiveName%7C0%26N%3D52

The subjective measures or rating scale techniques are based upon the ability of the typical person to be introspective concerning his or her own cognitive processes and, therefore, be able to assign values with reasonable accuracy (Paas, Tuovinen, et al. 2003; Zhang and Luximon 2005). Recent studies examined the effectiveness of various methods to measure workload. The National Aeronautics and Space Administration-Task Load Index (NASA-TLX) and Subjective Workload Assessment Technique (SWAT) were evaluated as the most widely used instruments by current researchers (Rubio et al. 2004; Zhang and Luximon 2005). The data analysis process between the two instruments makes the choice of which methodology to use easier since both are proven and reliable instruments. The SWAT pretask procedure requires respondents to be placed into subgroups based on the dimension choices followed by a sorting of twenty-seven cards for placement into groups (Zhang and Luximon 2005). The complexity of the SWAT analysis procedure makes the NASA-TLX instrument the better choice and one less prone to errors during the analysis phase of the study.

The NASA-TLX is a multidimensional subjective workload assessment tool originally designed to measure the physical and mental workloads faced by military pilots (Zhang and Luximon 2005). NASA-TLX allows users to perform subjective workload assessments on operator(s) working with various human-machine systems. NASA-TLX is a multidimensional rating procedure that derives an overall workload score based on a weighted average of ratings on six subscales (Zhang and Luximon 2005). Use of a subjective instrument such as NASA-TLX has been chosen to help quantify the learner's perceptions of the cognitive load experienced during the various challenges using the conceptual model of the five challenges typically faced by new asynchronous e-learners proposed by Tyler-Smith (2006).

## METHODS

This study focused on examining the relationships between variables to determine what, if any, relationships existed between the cognitive workload experienced by e-learners and their perceived ability to complete an e-learning course (McQuaid 2009). The research design focused on the cumulative and task-specific cognitive loads experienced by e-learners resulting from each of the five typical tasks required for participation online and the relationship with perceptions of their ability to complete the course (Tyler-Smith 2006). See Figure 2.

The design for this study was both descriptive research and correlation explanatory design. Gall, Gall, and Borg (2003) "emphasize that descriptive research is a type of quantitative research that involves making careful descriptions of educational phenomena" (374). Descriptive statistics were employed to describe survey data and provide information concerning the

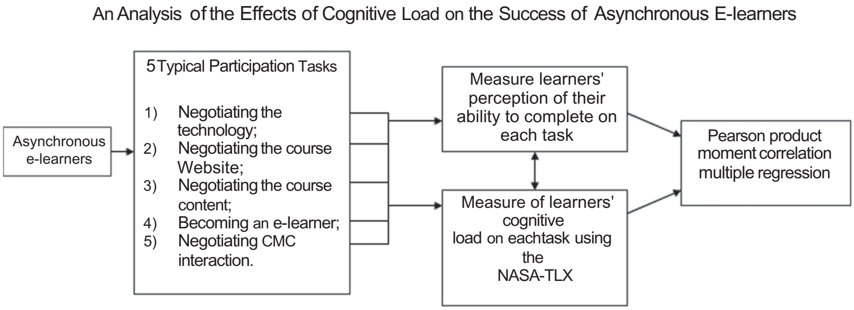


***Figure 2.*** Block Diagram Showing Study Research Design.



spread (range), center, and dispersion (standard deviation) of the respondent's choices (Howell 2004).

Creswell (2005) defines the explanatory design as "a correlational design in which the researcher is interested in the extent to which two variables (or more) co-vary, that is, where changes in one variable are reflected in changes in the other" (327). In broad terms, the explanatory design explains the relationships between variables within the study. Explanatory designs cannot establish cause and effect but can provide inferences concerning the apparent direction and strength of the relationship between variables (Creswell 2005). The complete study variables and statistical data are listed within Appendix B of the author's original study for each task and include the respondents' confidence in their computer ability, Internet ability, completing the course, their generational group, and finally their asynchronous experience known as completed classes (McQuaid 2009).

## Data Collection Strategies

This study used a Web survey instrument posted on Inquisite® to gather data for the measurement and analysis of variables to determine the effects of cognitive load on the tasks typically experienced by e-learners. After the completion of a short pilot study, the participant invitation was posted in the announcement section of the virtual course room for each new asynchronous class using an *Invitation to Participate in the Study*. The invitation was posted no sooner than the third week of each class to allow learners time to acclimate themselves to the demands of the online courses. Specific dates would depend on problems found both procedurally or within the survey instrument and a second pilot study may be scheduled should the need arise.

The instrument was divided into three major parts. Section 1 contained demographic information about the learners, including determining online experience, generational group, computer confidence, Internet confidence, and asynchronous courses completed. Section 2 contained the NASA-TLX for each of the five tasks, consisting of a weighting section (seventeen pairs) and a difficulty scale section to identify the specific types of loads experienced by the learner. The questions in Section 3 were of a standard Likert design and consisted of questions about the effect of the five tasks to ask the learners on their perception of being able to complete the course and to rank the tasks in order of difficulty.

The instrument's reliability and validity was within allowable ranges due to the use of a previously established measurement instrument. However, results were confirmed using a Cronbach's alpha coefficient analysis on all returned surveys to verify the instrument's internal consistency on Sections 1, 2, and 3 (Howell 2004; Pallant 2005).



## RESULTS

All of the research questions resulted in the same task variable, confidence to complete the course (Q34, Q35, Q36, Q37, Q38), as the only statistically significant outcome. Each relationship demonstrated a medium strength (*r*.30–.49) correlation to the cognitive load measured in each task. These tasks are (a) negotiating the computer-based technology, (b) negotiating the virtual course room, (c) negotiating the course content, (d) becoming an e-learner, and (e) negotiating the CMC interactions. A list of the study's independent variables is available in Table 1.

**Table 1.** Comparison of Significant Study Variables ($N = 81$)

| Questions/Tasks | Significant variables | $r$ | $F$ | $R^2$ | *Sig* |
|---|---|---|---|---|---|
| Q1. Ability to operate the technology | Task 1 Confidence | −.481 | 4.78 | 24.2% | 000 |
| Q2. Ability to navigate the course site | Task 2 Confidence | −.336 | 2.55 | 14.5% | .05 |
| Q3. Ability to engage with content | Task 3 Confidence | −.329 | 2.48 | 13% | .05 |
| Q4. Ability to function in role of e-learner | Task 4 Confidence | −.296 | 2.38 | 13.7% | .05 |
| Q5. Ability to participate via CMC | Task 5 Confidence | −.357 | 3.12 | 17.2% | .05 |

$r$ = correlation coefficient; $F$ = the $F$ statistic provides a test for the statistical significance of the observed differences among the means of two or more random samples; $R^2$ = coefficient of multiple determination; *Sig* = statistical significance; CMC = computer-mediated communication.

*Research Question 1: What are the interrelationships between ability to operate the computer-based technology needed for online participation and the learners' perception of confidence to complete the course?*

The results demonstrated that the learners' confidence in completing the course was the most important variable examined. The results for RQ1 demonstrated a relationship between the Task 1 cognitive load and Task 1 confidence (Q34). This inverse relationship indicated that the more confident the learners were in their overall computer abilities, the less cognitive load they would experience because of the first participation task.

*Research Question 2: What are the interrelationships between ability to function or navigate within the virtual course room and the learners' perception of confidence to complete the course?*

The results indicated that the learners' confidence in their ability to complete the course (Q35) was the most important variable examined. The interpretation derived from the data illustrated that as participants' self-efficacy level measured high, their cognitive load measured low and conversely, as self-efficacy measured low, cognitive load measured high.

*Research Question 3: What are the interrelationships between ability to engage with the instructional content and the learners' perception of confidence to complete the course?*

The results indicated that the learners' confidence in their ability to complete the course (Q36) was the most important variable examined. The interpretation derived from the data illustrated that as participants' self-efficacy level measured high, their cognitive load measured low and conversely, as self-efficacy measured low, cognitive load measured high.

*Research Question 4: What are the interrelationships between ability to function in the role of an e-learner and the learners' perception of confidence to complete the course?*

The results indicated that the learners' confidence in their ability to complete the course (Q37) was the most important variable examined. The interpretation derived from the data illustrated that as participants' self-efficacy level measured high, their cognitive load measured low and conversely, as self-efficacy measured low, cognitive load measured high.

*Research Question 5: What are the interrelationships of ability to use computer-mediated communications (CMC) and the learners' perception of confidence to complete the course?*

The results indicated that the learners' confidence in their ability to complete the course (Q38) was the most important variable examined. The interpretation derived from the data illustrated that as participants' self-efficacy level measured high, their cognitive load measured low and conversely, as self-efficacy measured low, cognitive load measured high.

## DISCUSSION

The critical determining factor in RQ1 was learners' confidence in their ability to complete the course. Before delving into this relationship, it is necessary to define the construct of the task-specific measures of confidence. *Confidence* is defined as a belief in oneself or one's own abilities and relates to the individual's sense of self. The concept applies widely across a variety of domains. A confident person tends to exhibit a sense of self in a variety of social and professional situations. The constructs of confidence and self-efficacy are interrelated with the difference between the constructs being related to the domain being examined. For example, a plumber may exhibit confidence on the job site but if faced with a non-plumbing-related home repair, be afraid or uncertain of his abilities. When the individual's perception of confidence is task specific, it is actually self-efficacy.

Self-efficacy varies according to the specific domain (task) and the individuals' knowledge and abilities (Bandura 1994). This complexity and specificity changed the confidence to complete measures from one of a simple perception of confidence to one of a perception of self-efficacy. The online survey question asked, "How did your technical abilities/computer skills effect the confidence you felt in your ability to complete the course?" This question exceeded a simple measure of one's perception of confidence and required a complex self-evaluation of domain-specific skills, knowledge, and abilities to ascertain if the respondent thought his or her computer skills were sufficient to complete the asynchronous course. The term *confidence* was chosen for use in the survey instead of self-efficacy due to being more socially recognizable and understood. Self-efficacy has been defined by Bandura (1986) as

> people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances. It is concerned not with the skills one has but with the judgments of what one can do with whatever skills one possesses. (391)

Procedural knowledge and technical skills are not always sufficient to elicit a desired outcome; the individual must make the determination to bridge the gap between can and will do. Facilitators can effect a participant's perception of his or her self-efficacy by providing examples of other learners' successes, which is a concept known as vicarious experience (Bandura 1986). Additional activities, geared specifically toward technological orientation, should gradually progress in difficulty during the orientation portion of the course, permitting the participants time to determine which skills they possess, then develop those they do not. These activities, if framed in a manner allowing peers to work collaboratively, will facilitate the development of the participants' social identities, invaluable for academic discourse and participant self-efficacy.

The Task 1 confidence relationship demonstrated that it was inversely related to the measured task cognitive load. The respondents' self-efficacy was the most important characteristic that reliably predicted cognitive demands. The study's demographics indicated that the majority of the sample used computer-based technology professionally, yet the measured cognitive load indicated that when faced with using the same online tools in an educational setting, the technology created the greatest participation demand on the respondents' attention, even after a minimum of three weeks of asynchronous course participation.

An interesting aspect of a nonsignificant relationship that logically should have related on Task 1 is the variable computer ability (Q2). Computer ability (Q2) in Task 1 was not statistically significant and contributed the lowest $\beta$ .008 value. The low standing of this predictor variable was puzzling, especially considering the growth of computer usage throughout society and the requirements of Task 1 (computer ability). The study demographics indicated that 82.7% of the sample reported being confident or strongly confident in their computer abilities and 97.5% reported using computers in the workplace to perform their jobs. With this level of computer integration, one would think that employee computer skills and abilities would be well established, especially considering that technological adoption seen in the sample exceeds many other industries.

Several external workplace studies have been conducted examining computer use in the workplace. One study commissioned by Microsoft (2003) titled *Accessible Technology in Computing—Examining Awareness, Use, and Future Potential* found that 85% of adults ages 18 to 64 use computers in the workplace. A 2005 report from the Bureau of Labor and Statistics (BLS) indicated that 55.5% of workers in the United States over the age of 16 use computers in the workplace (BLS 2005).

When these external examples were compared with the study data, which reported 97.53% of respondents used computers in the workplace, it became clear that the group under study exceeded the typical percentages seen in the workplace. This study's results indicated that the sample exceeded Microsoft's sample by 12.5% and the 2005 BLS report by 22%. Clearly, the average worker in the sample should be proficient with the use of computer-based technology, yet 17.3% responded that they were not overly confident in their computer abilities.

The only observable interrelationship on Task 2 is learner confidence or self-efficacy. The structure of Task 2 required participants to develop a mental model of the virtual classroom's organization. Until an understanding of the classroom structure is formed, the learner must examine, explore, and seek to locate the tools and resources necessary for his or her online participation, requiring participants to focus cognitive resources. Inexperienced learners can become disoriented, adding unnecessary cognitive load that will limit the learner's mental resources available for use on learning the content (Task 3). Facilitating learner navigation within the course aids in the building of mental models representing the site design and more quickly orients new learners to the virtual course room. Palloff and Pratt (1999) recommended that instructional designers provide a syllabus to guide course participants in developing their mental model. Maintaining similar structure and terminology throughout the course site and orientation documents reduces cognitive demands placed upon learners (Palloff and Pratt 1999). The respondents indicated the cognitive demand experienced during this task was the second largest, surpassed only by Task 1, ability to use computer-based technology.

Another approach to address unnecessary cognitive demands of course room navigation involves the use of graphical orientation clues. These clues provide visual feedback about the learner's relative position within the course site. Asynchronous courses can consist of many layers of pages and folders, depending on the complexity of the subject matter, requiring learners to search through a great deal of debris before finding what they require. One example is to provide navigation feedback known as bread crumbs or trails.

Palloff and Pratt (1999) agree with the importance of incorporating orientation activities and navigation features in the design of virtual course rooms and with the need to reduce the cognitive demands placed on learners. They also emphasize that the design goal is to make the structure of the virtual classroom logical, organized, and familiar, minimizing additional demands on new users.

The only observable interrelationship on Task 3 is learner confidence or self-efficacy. This task required the learner to engage with the instructional content of the program. The purpose of limiting cognitive demands imposed by the other tasks is to provide the learner with sufficient remaining cognitive resources for learning the instructional content. The learner must have the willingness to engage with the course content and complete the activities and assessments that comprise the curriculum.

Task 3 results represented the expected cognitive demands necessary to engage in learning, which can be either intrinsic or germane loads. This demand was related to the difficulty of the content and the prior learning of the individual. All learning, traditional as well as online, generates a demand upon the individuals attempting to master the content. Ancillary Tasks, 1, 2, 4, and 5, support Task 3 with skills and experiences needed to sustain the course learning objectives. E-learning inherently creates additional demands upon the learner due to the use of technology, including the need for learners to be more self-sufficient than their peers taking traditional classes. The cognitive measures indicated that the study sample found both Task 1 and Task 2 to be more demanding than the instructional content, meaning that the majority of learners found the online tools more challenging than the course content. It would seem logical to assume that as the participant gained in online experience, the cognitive demands of Tasks 1, 2, 4, and 5 would gradually reduce, allowing the learner to focus more resources on Task 3. The study results do not support this conclusion and, in fact, the predictive model for Task 3 is only 13% ($r^2$). If this assumption were correct, a negative relationship between learner asynchronous experience and task cognitive load should have been noted. The results can be interpreted to mean that although this task statistically related to the learners' feelings of self-efficacy, the difficulty of the content and the prior learning of the respondents must also be considered.

Prior learning is another factor that affects cognitive load and, in this study, no controls were placed on respondents to establish a base knowledge level; nor was the sample restricted to one specific course. In fact, the participants of seven courses were offered the survey and the content difficulty ranged from mandatory supervisory training to very extensive medical subjects directed at staff physicians.

Most adults have developed an understanding of formal training and education from their time spent in primary, secondary, or postsecondary education programs, which typically hold to the pedagogic model of being instructor centered and led (Conrad and Donaldson 2004). The inexperienced e-learner must abandon his or her existing linear mental models of instruction and embrace new models based on nonlinear approaches that require learners to become self-directed, motivated, and active participants (Tyler-Smith 2006; Watkins 2005). This change will require e-learners to continue adapting to the demands of technology by developing ad hoc strategies to fill in the gaps between their older, traditional education skills and the requisite new skills (Watkins 2005). This conversion process will require time, experience, and confidence.

The mean value of the cognitive load measured on participation Task 4 is 38.462*M*, which is the lowest of the cognitive load mean measurements. This measure is particularly interesting because it represents the lowest demand from the five participation tasks, indicating that the participants had previously adapted to the changes necessitated by e-learning and were becoming comfortable with their new learning roles. The demographics section of the online survey queried respondents' prior educational experiences to ascertain how much time had been expended in previous asynchronous classes, from any source, and if this created any current cognitive load effects. The results indicated that 29.7% of the sample had no prior asynchronous experience and 39.2% had completed one prior asynchronous course. The remaining choices included 2–3 prior courses 16.2% ($n = 12$), 4–5 prior courses 4.1% ($n = 3$), 6–7 prior courses 1.4% ($n = 1$), and finally, 10 or more prior courses 9.5% ($n = 7$).

Clearly, the outcomes for Task 4 indicated that the majority of the sample had very limited asynchronous course experience, which is not surprising given the statistics from American Society Training and Development (ASTD). The *2008 State of the Industry Report* indicated that 32% of all workplace education in 2007 was technology based, but only 3.01% was delivered via asynchronous tools (Paradise 2008). The other online modality measures for 2007 indicated that synchronous, instructor-led online training usage represented 6.39% and computer-based, self-paced training represented 21% of the total. Although the overall growth of technology-based training is impressive—6.45% from 2004 to 2007—the growth of asynchronous-based training has been very limited, .25% from 2004 to 2007 (Paradise 2008). It appears that, despite the limited growth of asynchronous training, other technology-based options have assisted learners in developing their online learning skills.

When immersed within an e-learning environment, students are empowered and encouraged independently to learn, which is a radically different approach from that utilized in a traditional classroom environment. An individual's level of self-efficacy determines his or her success in an e-learning course and, as determined by this study, maintains the only relationship to the respondents' cognitive demands.

The online collaborative environment is an essential component of the asynchronous course. Collaborative learning results from group identification and leads to concern for other members of the community with a desire to combine resources for collective success. This perspective suggests that learner identification with the group is a powerful source for achievement and motivation to learn with others (Garrison and Anderson 2003; Jonassen, Peck, and Wilson 1999; Michinov, Michinov, and Toczek-Capelle 2004). For virtual communities to be successful, participants must feel a sense of comfort that will enable them to participate in the online environment. Participation requires that learners utilize their computer and technical skills to facilitate this process. Ongoing virtual discussions can traverse many days and extend to many levels as learners explore one another's experiences and thoughts on new concepts. The cognitive demands tend to be high due to the many skills, knowledge, and effort necessary to fulfill this particular activity. The technology will eventually become transparent as the learners become proficient with the communication tools. Noting peers actively participating contributes to the individual's sense of self-efficacy. The social learning aspect of the discourse evolves through the building of community to sharing of ideas and knowledge. A benefit of online asynchronous learning comes from the effort and research accomplished in support of the textual-based discussions.

Minimizing the cognitive load experienced by learners during an educational event is a concern. The online discussions are the heart of the e-learning process, and Garrison and Anderson (2003) comment that the discourse is the "essence of an educational experience as evidenced by a collaborative inquiry-based process" (84). According to Garrison and Anderson, dialogue in an asynchronous course room is best facilitated by assuring the administrator's expectations and ground rules are acknowledged at the onset of the session, then reiterated as required during the discussion. Clear expectations will reduce frustration and unintended extra work due to misunderstandings. Learner prior knowledge and online experience should be considered before making difficult assignments. Providing casual discussion opportunities early will allow time for the learners to master the online CMC tools. As participation skills improve, discourse assignments should gradually require the learners to make higher-level responses, covering the instructional content to date, and to incorporate additional research to support their position (Clark and Mayer 2003).

The learner roles of engagement as defined by Conrad and Donaldson (2004), who called this the concept phases of engagement, emphasize that time must be dedicated for people to become completely oriented to the community. The administrators assist by selecting activities that encourage collaboration among members of the forum. Administrators can encourage participation by asking for introductions, posting informative articles for community comment, and interjecting comments early in the discussion phase that prompt additional engagement and sharing of ideas. Online administrators establish the tone for the community, make the tone inviting, and encourage people to participate and take risks.



## CONCLUSIONS

The results of this study indicate that learner confidence, or more specifically self-efficacy, is the single most important factor in determining the success of e-learners. Care should be taken to screen potential learners assuring that they have minimal requisite knowledge to participate effectively and the confidence to complete the experience. Many assessment tools are available for evaluating a learner's openness and attitudes concerning online learning. Scaffolding techniques should be employed in courses with new or inexperienced learners and gradually removed (fading) as the learner becomes more proficient in the use of online tools, providing control for avoidable extraneous demands.

Based on the cognitive load values in each of the five tasks, it appears that insufficient time was expended orienting learners to the virtual classrooms and to the technology necessary for participation. Faculty and course designers should provide sufficient opportunities for participants to form an online community by keeping the initial topics simple and the discourse requirement high. Encouraging discussions on a variety of common-interest topics would serve to familiarize learners with the online tools and virtual course room organization, facilitating the process of forming a social online community. To aid in the orientation to the virtual classroom, system administrators should insist the faculty include course documents that graphically display the layout and location of course materials and resources.

The use of the cognitive load theory is a practical rich approach toward understanding and quantifying the complicated participation demands placed upon online learners. The organization of the tasks as recommended by Tyler-Smith (2006) may not be the most useful approach, especially when using a subjective tool to conduct the cognitive load task measures. Consideration should be directed at combining several of the ancillary participation tasks to reduce the quantity of measuring and further focus the results. Logical combinations would be to measure computer-based technical skills with CMC communications (Task 1 and Task 5) and virtual classroom navigation with e-learning skills (Task 2 and Task 4). Another approach could be to separate participation and learning into separate categories. This reduction in the number of scales would allow the respondents fewer items and concepts to reflect upon and potentially improve the validity of the instrument. This combination could also reduce the amount of overlap between the various tasks, serving to improve further the survey validity.



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