Effective curriculum design is a critical component to successful student learning. The design, structure, content, technologies, and delivery mode chosen by the instructor/designer can greatly affect the quality of the course. A poorly designed course can impede student learning; conversely, a well-designed course can lead to learning experiences that optimizes learning capacity including transfer of knowledge, defined as “the ability to extend what has been learned in one context to new contexts” (Bransford, 1999, p. 39). As Bransford, Brown, and Cocking (1999) wrote in How People Learn, “Educators hope that students will transfer learning from one problem to another within a course, from one year in school to another, between school and home, and from school to workplace” (p. 39). Thus, one of the ultimate goals of a curriculum designer is to create learning experiences that result in transferable skills.

In the online learning environment, curriculum designers must devote even more attention to course design and activities due to the potential lack of face-to-face interaction between the instructor and learner and learner and his/her peers. Distance learning, e-learning, or online learning, are often used interchangeably; however, all of the terms imply computer-mediated instruction in some form. In the majority of the material I have researched, distance learning covers learning delivered via many different media such as television, or videotaped courses. E-learning and online learning both indicate computer-mediated instruction where most, if not all, of the instruction takes place via a computer with and Internet connection. Dialogue takes place through the Internet using asynchronous and/or synchronous communication tools. Typically, teacher and students are at different locations, sometimes at opposite ends of the continent. Within the realm of e-learning, there exists fully asynchronous courses, blended (or
hybrid) courses in which some face-to-face sessions are replaced with online components and web-enhanced courses where educational technologies are used to supplement traditional courses. In all forms of e-learning, however, good curriculum design is a critical component.

Johnson (1969) wrote that there are three distinct notions of what curriculum design is, “(a) An arrangement of selected and ordered learning outcomes intended to be achieved through instruction, (b) An arrangement of selected and ordered learning experiences to be provided in an instructional situation, and (c) A scheme for planning and providing learning experiences” (Johnson, 1969). Johnson also stressed that curriculum design should include both design and instruction. It appears that many current models of curriculum design and instructional design stem from Johnson’s forty-year old definition. Curriculum design takes into account expected learning outcomes, teaching methods, learning activities, and assessment and evaluation. Curriculum designers typically follow a systematic approach to instructional design based on foundations of educational theory and pedagogy. Examples of such instructional design models include ADDIE (analysis, design, development, implementation, and evaluation), or Dick and Carey’s model, which incorporates many aspects of the ADDIE model (Gagne, 2005). Magliaro and Shambaugh (2006) found that one of the values of a systematic approach to instructional design is “identifying what is to be learned, exploring teaching options, assessing learning, and evaluating the overall instruction and student learning. The value of ID is to keep important issues of learning at the forefront of the development effort (Magliaro & Shambaugh, 2006). Any of the several instructional design models that the curriculum designer chooses requires attention to the management of cognitive load. The more precisely the designer follows the model, the easier it will be to anticipate and manage cognitive load.
According to Mayer (2008) in *Learning and Teaching*, cognitive load theory is based on the idea that “cognitive capacity for learning is limited” (Mayer, 2008, p. 24). The three main sources of cognitive load that may occur during learning are intrinsic, extraneous, and germane (Mayer, 2008, p. 24). Mayer explains intrinsic cognitive load as the amount of cognitive processing required to comprehend the material, depending on its conceptual complexity. (Mayer, 2008, p. 24). Germane cognitive load can occur when learners are engaged in deep cognitive processing. The learner is engaged in making sense of the material using familiar or new schema. Germane cognitive load can be encouraged by incorporating metacognitive activities (e.g., reflections and journals) into the activities (Mayer, p. 25). Extraneous cognitive load is the amount of cognitive capacity used for cognitive processing that is not relevant to the goals of instruction, and does not contribute to learning (Mayer, p. 24). Extraneous load can be reduced through effective instructional design such as reducing the amount of extraneous information, logical organization of material, and visual identifiers—all key principles of good course design.

Cognitive overload can easily occur when a lesson is poorly designed, disorganized, and contains irrelevant information. With all the technologies and tools available to teachers today, it is often that we find courses with several conflicting components such as slide shows, graphics, animations, podcasts, or blogs, with little or no purpose. Cognitive load increases as the amount of information to be processed increases, and the more extraneous load that is in the course the less germane will be in effect. Thus, it is the instructional designer’s responsibility to reduce the amount of extraneous load so that learning can effectively take place. This is consistent with Mayer’s (2008) contention that, “instruction should be designed to manage intrinsic load, minimize extraneous load, and promote germane load” (Mayer, 2008, p. 24).
Using multimedia in courses requires special attention to cognitive load theory. Hogg (2008) explains “Each individual has unique past experiences which influence structuring and ordering, and no two individuals "see" alike, and this presents challenges for those who teach today with multimedia. With today's sophisticated media use cognitive load has taken on a new significance in the classroom environment” (Hogg, 2008). Hogg (2008) states, “instructional design is of prime importance to reduce extraneous cognitive load and increase germane cognitive load,” consistent with the findings from Mayer’s research on cognitive load theory. Hogg’s (2008) speculation on the design of instructional material includes “awareness and integration of prior knowledge with new information, integration of multiple presentation methods, instructional strategies leading to task automation, and flexible time components” (Hogg, 2008, p. 175).

Effective curriculum design must take into consideration how to reduce, or at least minimize, extraneous cognitive load. This is particularly important to fully online courses, for the instructor is unable to see the reactions of the learners as they can in a traditional classroom. Feedback is limited by the constraints of the technology that is employed. Morrison and Anglin’s (2005) research on cognitive load theory revealed that “the design and development of e-learning materials presents the instructional designer with an environment, opportunities and constraints quite different from those associated with the design of instruction for a traditional classroom context. The major difference is that in face-to-face environments, the instructor can rely on feedback from the students if they fail to understand concepts (Morrison & Anglin, 2004). Morrison and Anglin’s (2004) research summary identified heuristics that instructional designers can use for “proper management of cognitive load through sound instructional design ... that lead to an understanding of the content by the individual learner who has the option of
learning 24/7” (Morrison & Anglin, 2004). Consistent with the principle of logical sequencing in courses, Mayer (2008) suggests as part of the cognitive model of instruction that one of the factors involved in the teaching-learning process be instructional manipulations, or “the sequence of environmental (i.e., external) events including the organization and content of instructional materials…” (Mayer, 2008, p. 21). Structure, organization, consistency, and logical sequencing are design principles that can help the instructor to manage the three areas of cognitive load. Rudka (2008) in an ETAP 519 class discussion provided a similar suggestion, that “by creating an organized learning environment, students will face the learning experience with a more confident outlook since there will be more consistency and less surprise. Organization and preparation of materials and teaching/learning methods possibly applies even more for an online course since students cannot rely on the face-to-face interactions and expressions that so often help clarify any uncertainties that might occur in a classroom setting (Rudka, 2008). Rudka also mentioned, “build upon students’ prior knowledge when teaching new material. Doing so can help students avoid cognitive overload since the learner will again approach the learning situation more confidently than if going into it feeling completely anxious or confused about the material being presented (Rudka, 2008; Mayer, 2003, pp. 80-87).

Morrison and Anglin (2005) evaluated research on cognitive load theory and e-learning and have provided suggestions on activities and teaching methods that may manage cognitive load. Suggestions to manage cognitive load are plentiful and varied—ranging from the didactic approach, to worked examples, to metacognitive activities. Morrison and Anglin commented on Holmberg’s research (1989) in that designers might develop a “guided didactic conversation or internal speech the student has with the instructor as the student processes the instructional materials to aid in cognitive processing (Morrison, 2005, p. 84; Holmberg, 1989). While the
didactic approach is teacher-centered, it could be adapted for an online, text-only based environment. Morrison and Anglin (2005) also suggested that worked examples or problem-based learning (PBL) can provide two contrasting approaches to instructional design. Worked examples provide a more guided approach than PBL, thus, this heuristic should be used for students with no prior knowledge of the subject, while PBL leans more toward a student-centered approach. Overocker (2008) provided the worked examples suggestion in response to a question posed in our ETAP 519 class discussion on managing cognitive load. According to Overocker (2008), “Many instructors choose to focus on reducing extraneous cognitive load through the use of various classroom activities that can free working memory, like worked examples” (Overocker, 2008).

Choosing technologies and multimedia in an online course should be carefully considered. With new technologies proliferating at such a rapid rate, there are a multitude of choices we have access to as part of education. As many instructors/designers try to improve their online courses through the incorporation of multimedia technologies, many incorporate the latest fads without careful thought as to whether it is aligned with the course learning objectives and student learning, which can often lead to cognitive overload. Bransford, Brown and Cocking (1999) in *How People Learn* recommend, “In general, technology-based tools can enhance student performance when they are integrated into the curriculum and used in accordance with knowledge about learning ...but the mere existence of these tools in the classroom provides no guarantee that student learning will improve; they have to be part of a coherent education approach” (Bransford, et. al, 1999)

Karademos (2004) conducted an assessment of the cognitive basis of instructional media and suggested that multimedia can be used to manage cognitive load because the learner can
divide their instructional time into segments, and the interactive nature of the tools he used in his research (i.e., Dreamweaver and Flash web composing software) can take into consideration multiple intelligences and learner experience. Karademos suggested using web editing software to align text with visuals and to create “advance organizers.” Karademos’ suggestions might be acceptable for the tech-savvy, but the available resources and skill level of the instructor should be considered before suggesting these tools to handle cognitive load. (Karademos, 2004).

Hogg and Eckloff (2008) recommend the following strategies for the design of instructional material. Their strategies can be adapted for any distance or e-learning situation, and can be used concurrently with most instructional design models:

1. Introduce information with a conceptual map based on the inferred level of prior knowledge of learners.

2. Increase working memory capacity by using auditory as well as visual information under conditions where both sources of information are nonredundant and essential to understanding.

3. If the visual channel is overloaded with germane processing demands, move a portion of the essential processing from a visual to an auditory channel presented as narration rather than on-screen.

4. If both channels are overloaded with necessary processing demands, separate and present information in manageable segments. Allow the learner to control the timing rather than presenting the material in one continuous unit.

5. Provide background information such as names and characteristics of elements.

6. Provide signals and cues to the learner on how to eliminate extraneous material.

7. Present additional connections for those who may disengage.

8. Place the necessary printed words with the corresponding parts of graphics to reduce visual scanning.

9. Avoid presenting identical streams of printed and spoken words.

10. Visuals and accompanying narration should be presented simultaneously, rather than successively, so there is no need to hold representations in memory.
11. Allow a learner to work through information at his or her own pace dependent on prior experiences.

12. Eliminate the working memory load associated with unnecessarily processing repetitive information by reducing redundant information.


van Merrienboer and Ayers’ (2005) article provided a summary of seminal research on cognitive load theory in the field of e-learning. Their findings are presented in three categories of instructional methods that: (a) help learners deal with the intrinsic complexity of instructional materials, (b) stimulate learners to invest mental effort in genuine learning, and (c) enable the assessment of differences in learners’ expertise levels into order to adapt to individual needs” (van Merrienboer & Ayers, 2005). Their findings have great implications for the future of cognitive learning theory, e-learning, and course design.

Research on distance and e-learning is still relatively new, but it is evolving almost as rapidly as the new technologies are as scholars attempt to find optimal curriculum design for 21st century learning in all teaching venues, either online, blended, or face-to-face learning environments. In all situations, effective curriculum design is a critical component to quality courses and successful student learning. With the onslaught of all of the new technologies, researchers in the field of computer mediated courses will be striving to learn more, explain more, and apply theories to guide curriculum design that result in quality learning experiences, and transferable skills for the successful 21st century learner.
References


