Assignment 1: Summary Paper

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Cognitive Architecture and Instructional Design

Overview

Designing effective instruction for learners requires an understanding of the capabilities of the human brain. Instructional designers with background knowledge on learning theories that have demonstrated how learners process information during learning are able to design effective instruction (Morrison, Ross, Kalman, & Kemp, 2011). Cognitive Load Theory (CLT) is one-theory instructional designers consider during the design process. The purpose of this paper is to summarize and analyze the components of the human cognitive architecture, the different types of cognitive load, and element interactivity in relation to designing instruction.

Human Cognitive Architecture

Sweller, van Merrienboer, and Paas (1998) discuss human cognitive architecture, which includes working and long-term memory and schema construction and automation. Working memory is the amount of information the human mind consciously stores during the learning process. The human mind can hold approximately seven pieces of information in working memory (Miller, 1956). Therefore, learning occurs primarily using long-term memory (Sweller et al., 1998). Long-term memory as the term implies is information stored indefinitely in the human brain for future retrieval (Ormrod, 2012). The number of items you are able to hold in your hands compared to the number of items that you can save on a digital storage device may be an easier way to think about the difference between working memory and long-term memory.

Schema construction and automation are also components of the human cognitive architecture that aid in the understanding of information processing (Sweller et al., 1998). Both schema construction and automation occur within the long-term memory component of the human brain. When the learner processes new information from working memory into long-term memory it is organized into schemas or categories (Ormrod, 2012).

Referring again to the analogy presented above, an example of *schema construction* would be the creation of file folders on the digital storage device to build a repository of knowledge. For example, the category of science would be the master folder. Then within the master folder other folders (subfolders) connected to that topic are stored. These subfolders store specific details to certain topics of the master folder. For example, in the science master folder, the subfolder living things would contain information on organisms such as plants and animals. *Schema automation* is the ability of the brain to retrieve stored information without thought at the appropriate time the information is needed (Sweller et al., 1998). Automation can be thought of as the search feature that can be used to locate files on a digital storage device. When a person inputs a term or terms into the search box files that contain all or part of the terms are returned in the query. During learning this automation happens as students make connections between new and previously learned information. For this reason, Ormrod (2012) stated the importance of activating prior student knowledge in order to facilitate these connections.

Cognitive Load and Element Interactivity

During learning three types of cognitive load (intrinsic, extraneous, and germane) impact a learner's ability to process information (Sweller et al., 1998). Intrinsic cognitive load refers to whether the learner perceives the knowledge they are learning as easy or difficult (Sweller, 2010). Instructional design elements that are not conducive to the learning goal are believed to cause extraneous cognitive load for the learner (Mayer, 2009). Germane cognitive load is the amount of thinking the learner must do during learning to process the newly acquired information into their long-term memory (Mayer, 2009).

Another important component to instructional design is considering element interactivity. Element interactivity includes the concepts or procedures learners are expected to learn or know during instruction (Sweller, 2010; Sweller et al., 1998). Students may encounter low or high

element interactivity during instruction. *Low element interactivity* is when "concepts or procedures" are learned independently of other "concepts or procedures", thus producing low cognitive load for learners (Sweller, 2010; Sweller et al., 1998). *High element interactivity* is when "concepts or procedures" are taught in conjunction with additional "concepts or procedures" and are unable to be learned independently from them. Learners experience higher cognitive load when instruction is designed with high element interactivity. For that reason, it is essential that intrinsic, extraneous, and germane cognitive loads as well as element interactivity are forefront in the mind of instructional designers.

Conclusion

Learning requires the consideration of many different components for cognitive processing to occur successfully during instruction. In this paper, the human cognitive architecture was explained using the analogy of a digital storage device with all of the folders on it were compared to long-term memory, schema construction and automation. Intrinsic, extraneous and germane cognitive loads impact a learners ability to process information during learning (Sweller et al., 1998). Designing instruction with the correct amount of cognitive load to keep the learner engaged but not overwhelmed is supported by the literature.

References

Mayer, R. E. (2009). *Multi-media learning* (2nd ed.). New York, NY: Cambridge University Press.

Miller, G. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *The Psychological Review, 63*(2), 81-97.

Morrison, G. R., Ross, S. M., Kalman, H. K., & Kemp, J. E. (2011). *Designing effective instruction* (6th ed.). Hoboken, NJ: John Wiley & Sons, Inc.

Ormrod, J. E. (2012). *Human learning* (6th ed.). Allyn & Bacon: Upper Saddle River, NJ.

Sweller, J. (2010). Element interactivity and intrinsic, extraneous, and germane cognitive load. Educational Psychology Review, 22(2), 123-138. doi: 10.1007/s10648-010-9128-5

Sweller, J., van Merrienboer, J. J. G., & Paas, F. G. W. C. (1998). Cognitive architecture and instructional design. *Educational Psychology Review, 10*(3), 251-295.