Yet another reconsideration of cognitive load theory

(conventional paper presentation)

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Introduction

Regardless the demonstrated explanatory power of cognitive load theory and its crucial role in the development of educational methods, the theory has been criticized and adapted frequently. For instance, Schnotz & Kürschner (2007) claim that the separate measurement of the 3 defined types is not feasible. Gerjets, et al. (2009) criticize the circularity in their definition and measurement. Sweller (2010) and Kalyuga (2011) appear to have given up on the notion of germane load as an independent source of load.

Yet another reconsideration

Let us consider working memory (WM) as an information transformation system (Sweller & Chandler, 1991) aligned to the multi-store model of Atkinson and Shiffrin (1968). Incoming information from sensory memory (SM) has to be transformed to a format suitable for WM and outgoing information has to be transformed for storage in long-term memory (LTM). This novel view entails slight but crucial differences to the definition of the central concepts of cognitive load theory.

Extraneous cognitive load (ECL) is the occupation of resources of WM to transform information from SM to a format suitable for WM. This process is called "*interpretation*", which is the translation of an external representation of information to an internal representation (i.e., a *mental image*). A distinction is made between *visual ECL* (~visuospatial sketchpad) and *auditory ECL* (~phonological loop).

Intrinsic cognitive load (ICL) is the occupation of resources of WM to transform information within the WM representation. This process is called "*reasoning*" (e.g., by deduction, induction, or abduction). Again, there are two subtypes: *declarative ICL* (related to facts) and *procedural ICL* (related to events). The addition of procedural ICL as a subtype comes from observations that learner control and task administration have been related to cognitive overload (Conklin, 1987).

Germane cognitive load (GCL) is the occupation of resources of WM to transform information from a WM to a LTM representation. This process is called "*learning*". It entails the construction and

automation of cognitive schemas. It makes sense to also distinguish between *declarative GCL* (to build expertise) and *procedural GCL* (to build experience) (cf. Squire & Zola-Morgan, 1991).

Cognitive overload is when the required instantaneous load exceeds WM capacity (considering the 3 as additive). Insufficient capacity for (visual or auditory) ECL results in interpretation errors. Insufficient capacity for declarative ICL results in conceptual errors. Insufficient capacity for procedural ICL results in procedural errors and/or in slower reasoning. Insufficient capacity for (declarative or procedural) GCL results in learning deficiencies.

Conclusion

These definitions have a number of advantages. (1) The explicit recognition of GCL explains the difference between problem solving with or without learning. (2) The definitions abstract from the application of learning. (3) They enable direct instantaneous measurement of the different types in the future (e.g., with EEG or MRI). (4) They provide an *explanation* for the described consequences of overload. (5) They facilitate reasoning about the link between the 3 types of load (information resulting from one transformation is the input for another transformation, one transformation can (un)intentionally reduce the need for another transformation, etc.).

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