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Should self-regulated learning be integrated with cognitive load theory? A commentary

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ABSTRACT

Research on either cognitive load theory or self-regulated learning usually proceeds without reference to the other theory. In this commentary, we have commented on the editorial introduction and the six papers included in this Special Issue intended to indicate possible links between the two theories. To assist in this process, we have analysed some of the characteristics of both theories that either facilitate or impede the establishment of links. We conclude that while links are possible, the many differences between the theories present considerable barriers that will need to be overcome.

1. Introduction

Cognitive load theory has undergone continuous development over the last three decades. The driver of that development has had two major sources: the generation of new data based on randomised, controlled trials that have suggested additions and modifications to the theory, and the incorporation of external theoretical constructs that resonate with the theory. Both sources of theory development have been critically important to the success of the theory. The collection of papers that are the subject of this commentary fall under the second category with the suggestion that self-regulated learning and cognitive load theory should be integrated.

Whether an external theoretical construct can be usefully integrated with cognitive load theory depends on the extent to which the new construct accords with the core constructs of the theory. The initial core constructs were the relations between working memory and long-term memory with the critical construct being the change in working memory limits from severely constrained when dealing with novel information to largely unconstrained when dealing with knowledge stored in long-term memory. Subsequently, those relations between working and long-term memory have led to concepts associated with the transformation of the complexity of knowledge with changes in expertise (Chen, Kalyuga, & Sweller, in press) leading to the central concepts of element interactivity and intrinsic and extraneous cognitive load. More recently, the addition of concepts from evolutionary psychology (Sweller, 2015, 2016b) have transformed cognitive load theory in the last few years. Based on this evolutionary perspective, cognitive load theory deals with domain-specific information that we have not especially evolved to acquire, leading to biologically secondary skills. A biologically secondary skill is a skill that we can acquire but that we have not specifically evolved to acquire. Almost every topic that is taught in educational and training institutions consists of biologically secondary knowledge.

In contrast, generic-cognitive skills that, because of their importance, we have evolved to acquire, are biologically primary (Geary & Berch, 2016; Sweller, 2016a). Our ability to recognise faces or to solve previously unseen problems using generic-cognitive skills provide examples. As we will suggest below, self-regulated learning is probably a generic-cognitive, biologically primary skill. Because we have evolved to acquire generic-cognitive skills, they do not need to be explicitly taught since they are acquired automatically. In contrast, in order to reduce working memory load, we do need to explicitly teach the domain-specific skills that are the subject of cognitive load theory.

The cognitive architecture used by cognitive load theory is based

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on this evolutionary framework with, for example, that architecture applying to biologically secondary but not biologically primary skills (Sweller, Ayres, & Kalyuga, 2011). The architecture assumes: a very large long-term memory; evolved procedures for obtaining information from other people; evolved procedures for generating information via problem solving when information from other people is not available; a limited capacity, limited duration working memory when dealing with novel information; an unlimited duration, unlimited capacity working memory when dealing with familiar information stored in long-term memory designed to generate action appropriate to the environment.

In this commentary, the extent to which the work reviewed deals with issues that can be integrated within this framework will be analysed. We will begin with the editorial introduction.

2. Review of papers

This Special Issue of Learning and Instruction is devoted to the suggestion that cognitive load and self-regulated learning theories can and should be combined into a single theory. The Special Issue begins with an argument by the editors, De Bruin and van Merriënboer (this issue), supporting this suggestion. In particular, they suggest that cue monitoring is an important consideration for both self-regulated learning and for subjective ratings of cognitive load. They surely are correct with respect to cue monitoring. Nevertheless, there are other critical aspects and the different intentions and goals of the two theories seem to us to present insurmountable barriers to integration.

The first barrier concerns the goals of the two theories. Cognitive load theory has only one ultimate goal to which all other goals are subservient: the generation of novel instructional techniques. The ultimate success or failure of the theory rests entirely on the cognitive load effects that have been generated with, to this point, none of those effects depending on teaching learners cue monitoring. Of course, the fact that cue monitoring has not generated cognitive load effects does not mean it will not do so in the future.

Cue monitoring is important to self-regulated learning theory but the goals of the theory seem to lie elsewhere than the generation of instructional effects. As far as we are aware, over the quarter century that self-regulated learning theory has been discussed, few, novel, instructional effects based on randomised, controlled experiments have been demonstrated. As de Bruin and van Merriënboer indicate when discussing self-regulated learning: “Actual effects on learning outcomes are understudied but essential to validate the effect of interventions” (P. 19). With their different goals, it may be possible but very difficult to combine the two theories.

The second barrier to integration concerns the theoretical concepts used by the two theories. They are not only different, some are contradictory. Currently, cognitive load theory assumes that instruction is primarily concerned with domain-specific, biologically secondary information that we have not specifically evolved to acquire rather than the far more important, generic-cognitive, biologically primary information that we have evolved to acquire (Sweller, 2015, 2016a, 2016b; Geary & Berch, 2016). Self-regulation is probably a generic-cognitive, biologically primary skill that due to its importance to human functioning, cognitive load theory assumes is acquired automatically and so cannot be taught. Cue monitoring, which is central to self-regulated learning also may be biologically primary. If this conceptualisation is valid, the paucity of instructional effects associated with self-regulation will be permanent. Self-regulation can and should be studied as a generic-cognitive, biologically primary skill but it should not be confused with an instructional theory. (It needs to be emphasised that with extensive practice over many years, biologically primary skills can be improved as seen in elite athletes engaged in primary skills such as running. Whether previously acquired self-regulatory skills can and should be similarly improved after years of practice remains to be seen.)

The Raaijmakers, Baars, Schaap, Paas and van Gog (this issue) paper was co-authored by Fred Paas and so is reviewed here solely by John Sweller without input from Fred Paas. This paper compared the effect of positive or negative feedback on mental effort ratings. Since its introduction as an independent measure of cognitive load by Paas (1992), this measure has constituted by far the most commonly used index of load used in the field. It consists of a single item asking participants to indicate how much effort they devoted to the task in hand. Responses are most commonly made on a nine-point scale that rates effort from very, very low (or extremely low) to very, very high (or extremely high) effort.

The reasons for the popularity of this technique are not hard to find. Firstly, it is very easy to set up and administer requiring no more than a minute or so of participants' time. Secondly, and more importantly, it is far more sensitive to differences in cognitive load than any alternatives that have been devised. Thirdly, on the available evidence, it has a high degree of validity. Many experimental results using the technique have accorded closely with theoretical predictions of cognitive load theory. For these reasons, since its introduction, most studies using cognitive load theory as a theoretical framework have either used the Paas scale or a derivative to provide an independent measure of cognitive load.

Given the popularity of the Paas scale, studies of its characteristics are important. The current paper studied the effect of feedback concerning the accuracy of problem solving moves in attaining the problem goal on subjective impressions of mental effort. If a problem solver is told that his or her moves are appropriate in attaining the problem goal does this information alter subjective ratings of mental effort compared to being told that the moves are inappropriate? The results indicated that being told that moves are inappropriate increased subjective ratings of effort compared to being told that moves are appropriate. The fact that actual mental effort is not the only factor determining mental effort ratings but that feedback concerning the content task performance also can affect the ratings is an important finding.

As the authors suggest, these results indicate that subjective measures of cognitive load should be administered prior to learners receiving feedback on their task performance since the nature of that feedback can itself alter subjective impressions of cognitive load. While the reasons for this result currently are unclear, users of the scale need to be aware of this important effect which should be readily avoidable under most conditions by appropriately timing the presentation of the scale.

The paper by van Loon, Destan, Spiess, De Bruin, and Roebers (this issue) compared a group of 5/6 year old children to a group of 7/8 year olds to investigate developmental differences in the use of cues and self-protection in self-evaluations of performance. Self-evaluations of performance are essential for effective self-regulation and subsequent performance (e.g., Dunlosky & Rawson, 2012). It was assumed that young children's self-evaluations are often overconfident, because they may not yet be able to take valid cues, such as perceived task difficulty and invested mental effort, into account. It is not clear at what age children become able to take item difficulty cues into account, and to what extent this cue use explains age differences and accuracy of self-evaluations. Interestingly, Van Loon and colleagues found no developmental increase in reliance on item difficulty as a cue for performance self-evaluation, which means that even the youngest children (5/6 years) made adaptive use of item difficulty for their confidence judgments.

This finding is important in the context of cognitive load theory,

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