A Motivational Perspective on the Relation Between Mental Effort and Performance: Optimizing Learner Involvement in Instruction

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Motivation can be identified as a dimension that determines learning success and causes the high dropout rate among online learners, especially in complex e-learning environments. It is argued that these learning environments represent a new challenge to cognitive load researchers to investigate the motivational effects of instructional conditions and help instructional designers to predict which instructional configurations will maximize learning and transfer. Consistent with the efficiency perspective introduced by Paas and Van Merriënboer (1993), an alternative motivational perspective of the relation between mental effort and performance is presented. We propose a procedure to compute and visualize the differential effects of instructional conditions on learner motivation, and illustrate this procedure on the basis of an existing data set. Theoretical and practical implications of the motivational perspective are discussed.

An increasing number of instructional theories stress the importance of rich learning environments based on real-life tasks as the driving force for learning. Such tasks are expected to help learners integrate knowledge, skills and attitudes, and improve transfer of what is learned to work settings or daily life (Merrill, 2002). However, a severe risk of such learning tasks is that learners may not be sufficiently motivated to deal with their complexity (van Merriënboer, Kirschner, & Kester, 2003). Moreover, learning tasks are often presented in electronic, online learning environments, which also pose high demands on learners' motivation and persistence (Frankola, 2001). Until now, cognitive load theory (CLT) has focused on the alignment of instruction with cognitive processes, without recognizing the role of motivation in training. The goal of this article is to introduce a new, motivational perspective. In particular, we will show that the constructs of mental effort and performance, which play a central role in CLT in defining the efficiency of instructional conditions, have both cognitive and motivational components.

The structure of this article is as follows

CLT

CLT (Paas, Renkl, & Sweller, 2003, 2004; Sweller, 1988, 1999) offers a versatile framework for understanding the instructional implications of the interaction between information structures and cognitive architecture.

CLT incorporates specific claims concerning the role of cognitive load within an instructional context and its relation to learning.

An important result of these activities was the recognition by Paas and van Merriënboer (1993) that measures of cognitive load can reveal important information about the efficiency of instructional conditions that is not necessarily reflected by traditional performance-based measures.

THE ROLE OF MOTIVATION

The efficiency perspective has enriched our knowledge of the cognitive effects of instructional conditions

Motivating students to achieve in e-learning environments is a topic of practical concern to instructional designers, and of theoretical concern to researchers.

Keller's (1983) ARCS (Attention, Relevance, Confidence, Satisfaction) model made a key contribution to motivational theory and instructional design.

A representative example of an instructional strategy that has been shown to have both cognitive and motivational effects on learning is practice variability.

According to Fisher and Ford (1998), the allocation of effort toward learning activities is driven by individual motivational processes, such as goals, incentives, individual personality differences, and metacognitive knowledge

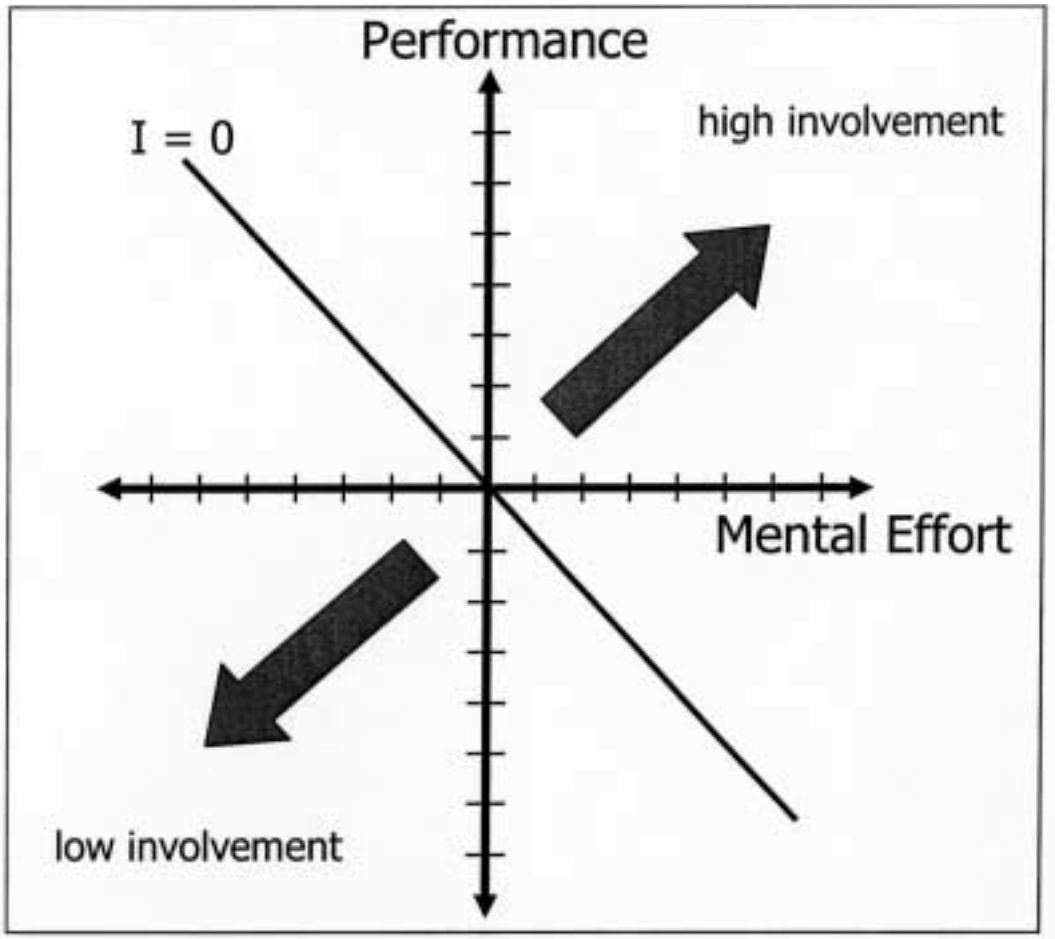
In the search for the conditions that need to be met to optimize learner involvement in learning environments, it is important to have an instrument to calculate and visualize motivation

THE CALCULATION OF TASK INVOLVEMENT

Consistent with the efficiency perspective introduced by Paas and van Merriënboer (1993; see also Tuovinen & Paas, 2004) we present an alternative motivational perspective on the relation between mental effort and task performance, which can be used to calculate and visualize the relative involvement in instructional conditions.

A series of steps needs to be taken to compute and visualize learner motivation in instructional conditions

Figure 1 □ Mental Effort – Performance coordinate system to visualize motivational effects of instructional conditions.



This formula[1] can be derived from computing the perpendicular distance of a point defined by the means of effort and performance, for each treatment group, to a zero involvement line, where $R + P = 0$.

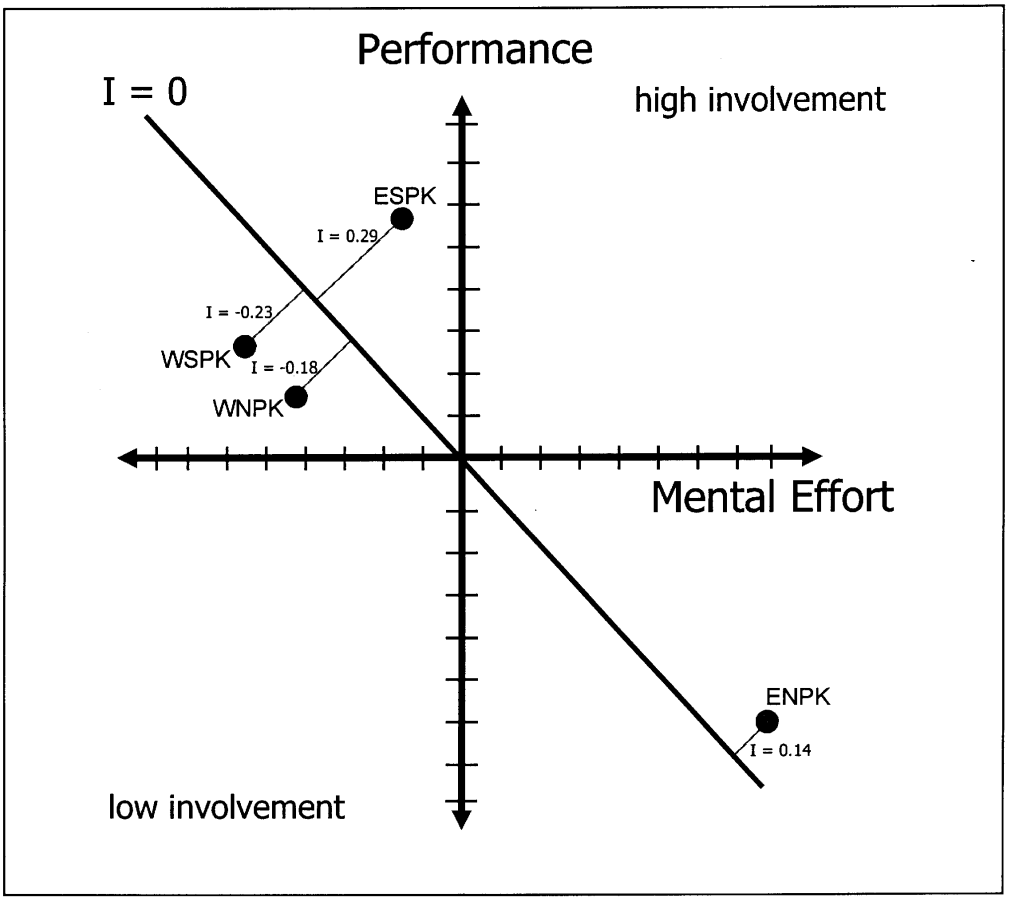
To show how the motivational perspective can be applied to real data, we use the data of Tuovinen and Sweller (1999).

It is now possible to compare the involvement of the worked examples and exploration groups by computing the involvement measures, using the above formula

DISCUSSION

Cognitive load theorists have focused on the alignment of instruction with cognitive architecture, without recognizing the need for training experiences to be coupled with the motivation to achieve well

Figure 2 ☐ Motivational effects of instructional conditions in Tuovinen and Sweller (1999).



Note. WNPK = Worked examples no prior knowledge condition, WSPK = Worked examples some prior knowledge condition, ENPK = Exploration practice no prior knowledge condition, ESPK = Exploration practice some prior knowledge condition.

The motivational perspective may provide an interesting alternative explanation to the prevailing cognitive account of the effects found by cognitive load researchers, such as the recently found "expertise reversal effect" (Kalyuga et al., 2003).

A multidimensional approach combining the mental efficiency and motivational perspectives shows great promise for the advancement of adaptive training research.

We believe that the approach to calculate and represent the relative involvement of students in instructional conditions can provide a valuable additive to research on the training and performance of complex cognitive tasks.

A final point of concern regarding the proposed motivational perspective relates to the notion that there are other factors than motivation determining the amount of mental effort invested. One of these factors, which is coupled with assessment of mental effort, is task difficulty as experienced by the learner. In fact, to measure the amount of mental effort, some cognitive load studies have used verbal labels relating to task difficulty, instead of mental effort. However, according to the model presented by Paas and van Merriënboer (1994b), (a) task difficulty represents just one of the three dimensions determining mental effort, next to (b) learner characteristics, and (c) task-learner interactions. As long as a task is not too easy and not too difficult, ratings of task difficulty may correlate highly with ratings of invested mental effort. Most important, it is clear that mental effort is a voluntary mobilization process of resources, which depends on the task demands in relation to the amount of resources the learner is willing or able to allocate. If learners perceive a learning task as too easy or too difficult, they may not be willing to invest mental effort in it, and cease to learn. So, to take advantage of the motivational approach to the relation between mental effort and performance, it is important to use rating scales with verbal labels related to invested mental effort. Despite these shortcomings, we believe that the presented motivational perspective can broaden the horizon of cognitive load researchers, and contribute to the optimization of learner involvement in instructional conditions. □