The Exploration of Intrinsic Cognitive Load on Mathematical Problem Solving: An Event-related Potential Study

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Intrinsic cognitive load refers to learners' mental workload affected by the difficulty of the learning materials but not by the instructional method (Sweller, 2010). We want to understand how learners' brain activity changes as learning materials become more and more difficult.

In this study, we tested college students(N=17) with algebra mathematics questions of three levels of difficulty: Easy (unary linear equation: one solving step), Medium (simultaneous linear equations: four solving steps), and Hard (simultaneous linear equations: seven solving steps). We adopted "Introducing a situation-Question presentation-Answer verification" task with "yes-no" two-alternative-forced-choice procedure (Leikin & Leikin, 2016) and recorded by EEG devices.

The behavior results indicated that accuracy and sensitivity (d prime) decreased but reaction time increased as the stimulus difficulty increased. We analyzed the EEG data of "introducing a situation" phase (participants look at the examination questions), the ERP results showed that N200 amplitude of Hard condition was larger than the others at OZ, and P2 component of Easy and Hard conditions were larger than Medium condition at FZ.

According to ERP data, our study had two main findings: (1) Medium and Hard conditions are consistent with cognitive load theory: the greater the cognitive load, the greater the amplitudes in vision and executive function related areas. (2) The cognitive processing of solving the unary linear equation may be different from solving simultaneous linear equations. In the former, after participants looking at the examination questions, the cognitive processing may be related to not only information encoding but also computation.

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