MULTIPLE REPRESENTATIONS, COGNITIVELY ACTIVATING TASKS AND THEIR ROLE IN UNDERSTANDING OF PHYSICS EXPERIMENTS

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THEORETICAL BACKGROUND AND AIMS

Theoretical background and aims

Mental representations and their interplay

Essential for science learning in general and for the understanding of experiments in particular (Gilbert & Treagust, 2009).

Representational competence

Ability to generate and use different specific descriptional and depictional representations of a subject or a problem in a skilled way (Dolin, 2007).

Obviously, students’ representational coherence ability (RCA) is an essential part of representational competence. For this study, representations are seen as coherent if they correspond in conjoint information.

Learning problems related to representations and experiments

Students’ representational competence was found wanting even at physics’ university level (Satter, 2005).

Students remember and understand too little from own (Novak, 1990) and lecture experiments (Crouch et al., 2004).

METHODS

Sample: 342 students (age = 13; SD = .68; German grammar school)

Design: quasi-experimental, one-factorial design with/without RATs (otherwise identical lesson plan, same teacher)

Independent variables: student’s RCA, broader conceptual understanding

Moderator variables: intelligence (Liepmann, 2010), possibly relevant school grades (German language, physics and mathematics), motivation

Statistics: item analyses & multilevel analyses for measuring changes (Göller et al., 2010)

Design features of RATs

Action for completing, correcting, adapting, comparing, & mapping of ≥ 2 involved representations. Explicit analysis of several connected representations (traditional tasks work typically with only 1 representation).

SELECTED RESULTS

Item analysis: Reliability and validity of the RCA-test

RCA of TG and CG are influenced by the following factors (n = 302)

Grade in math: \( \omega^2 = .072, p < .001 \) (medium effect)

IQfigural reasoning: \( \omega^2 = .035, p < .001 \) (small effect)

Grade in physics: \( \omega^2 = .018, p < .012 \) (small effect)

Conceptual understanding (pretest): \( \omega^2 = .013, p < .026 \) (small effect)

(Results below are adjusted for these influences)

Inference statistics

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REFERENCES


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CONCLUSIONS & OUTLOOK

A relatively short intervention (6 x 45 min) targeted at experiment-related representations in ray optics and coherence between them, can lead to significant and practically important improvement of student’s representational coherence ability and therefore student’s experiment related understanding (domain specific for image formation). The concept test targeted at a broader area of ray optics, it is probably therefore too unspecific to show effects in the researched area. Detailed analyses of subdimensions are in progress.

PROGRESS OF THE WORK

Start of Ph.D. study

Pilot study

main study

Thesis, disputation, publication