TRACING TO LEARN IN STEM SUBJECTS

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THEME:

Innovative STEM pedagogy and curriculum

BACKGROUND AND OBJECTIVES

Many students find STEM lessons intellectually challenging as well as unmotivating; hence, there is a constant need for lessons that both engage students and manage cognitive load. This workshop reviews an innovative instructional design, the *tracing effect*, with broad applicability to STEM education.

The tracing effect occurs when students are explicitly guided to use their hands to learn while studying lesson materials. Tracing refers to moving the index finger along specified elements of the diagram, e.g., arrows representing key processes in a diagram (Ginns & King, 2021), or highlighted elements within worked examples (Wang et al., 2022). Tracing actions may also be used alongside pointing actions while studying, e.g., pointing at the word/process in the text then pointing at a corresponding location on the diagram (cf. Ginns & King, 2021).

Benefits of tracing or tracing plus pointing have now been demonstrated in over a dozen randomized controlled trials, including classroom-based studies, and across multiple lesson topics and age groups. Drawing on an evolutionarily informed cognitive load theory (Paas & Sweller, 2012), tracing is theorised to be an example of *biologically primary knowledge* (knowledge we are genetically predisposed to develop straightforwardly without conscious effort) that can support construction of *biologically secondary knowledge* (knowledge that requires substantial time, cognitive effort, and instructional support to develop – including STEM-based lnowledge).

STRUCTURE OF THE SESSION

This workshop will be of interest to teachers, instructional designers, and educational researchers, as the presenter will (a) review theory and research on the tracing effect, (b) describe general principles for designing effective tracing/pointing instructions, and (c) encourage discussion of novel ways tracing/pointing might enhance STEM teaching and learning. In this last discussion section, breakout rooms will be used to support cross-fertilization of ideas among participants, with an online poll (e.g., Padlet) for capturing participants' suggestions.

IMPLICATIONS

Tracing is a simple, evidence-based, effective, and zero-cost learning strategy with potential to enhance learning across a broad range of STEM topics.

REFERENCES

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