

Chapter 15

Learning in the Digital Age with Meaning Equivalence Reusable Learning Objects (MERLO)

Masha Etkind

Ryerson University, Canada

Ron S. Kenett

KPA Group Ltd., Israel & University of Turin, Italy

Uri Shafrir

University of Toronto, Canada

ABSTRACT

In this chapter we describe a novel pedagogy for conceptual thinking and peer cooperation with Meaning Equivalence Reusable Learning Objects (MERLO) that enhances higher-order thinking; deepen comprehension of conceptual content; and improves learning outcomes. The evolution of this instructional methodology follows insights from four recent developments: analysis of patterns of content and structure of labeled patterns in human experience, that led to the emergence of concept science; development of digital cyber-infrastructure of networked information; research in neuroscience and brain imaging, showing that exposure of learners to multi-semiotic inductive problems enhance cognitive control of inter-hemispheric attentional processing in the lateral brain, and increase higher-order thinking; research in evolutionary dynamics on peer cooperation and indirect reciprocity, that document the motivational effect of knowledge of being observed, a psychological imperative that motivate individuals to cooperate and to contribute to the common good.

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INTRODUCTION

The chapter describe pedagogy for conceptual thinking and peer cooperation that enhances high-order thinking, deepen comprehension of conceptual content, and improves learning outcomes, through three interactive learning processes:

- Interactive Concept Discovery (InCoD) with conceptual curation and CONCEPEDIA (Shafrir & Etkind, 2011).
- Meaning Equivalence Reusable Learning Objects (MERLO) Cooperative/Interactive/Formative/Diagnostic (CIFD) assessments (Etkind, Kenett, & Shafrir, 2010; Etkind & Shafrir, 2011; Shafrir & Etkind, 2006).

Development of learners' meta-cognitive skills: peer cooperation; knowledge of being observed; self-evaluation; reflection (Nowak & Highfield, 2011; Donovan & Bransford, 2005, p. 407-415).

BACKGROUND

Traditional learning assessments often include structured items that focus on information and on application of procedures, such as true/false and multiple-choice questions. Results of such assessments demonstrate memory of facts, and correct execution of multi-step problem-solving procedures: 'what is taught in schools emphasizes veridical, rather than adaptive, decision making. Most course work – and the resulting tests – ask students to search for the unique answers to concrete and unambiguous questions' (Sousa, 2009, p. 30). Such learning assessments are situations where *the student's mind is being used as a storage-and-retrieval system, a task for which it is not particularly well adapted* (Box, 1997, p. 49). In contrast, assessment of conceptual thinking includes unstructured items - inductive questions

that focus on the meaning of conceptual situations: 'this sets the mind free to do what it does best - be inductively creative' (ibid).

The importance of conceptual thinking skills is now recognized as a cornerstone of effective learning, *understanding facts and ideas in the context of a conceptual framework* (Bransford, Brown & Cocking, 2004), as ways of thinking that explore patterns of equivalence-of-meaning in ideas, relations, and underlying issues. Conversations among content experts often reveal a common trend to clarify statements by re-formulating the issue under discussion from alternative points-of-view that share equivalence-of-meaning. These spontaneously formulated statements of complex issues are often encoded in alternative representations in different sign systems (e.g., text; images; diagrams; equations) that illustrate different aspects of the conceptual situation under discussion.

Meaning equivalence is a construct that denotes commonality of meaning across representations: a polymorphous - one-to-many - transformation of meaning. The related construct of representational competence is the ability to trans-code equivalence-of-meaning in multiple representations within and across sign systems (Shafrir, 1999; Sigel, 1954; 1993; 1999). Learning assessments based on meaning equivalence with unstructured items capture this important aspect of conceptual thinking.

Pedagogy for conceptual thinking and peer cooperation has evolved since 2002 through sequential stages of development, testing, validation, and implementation (Etkind, Kenett, & Shafrir, 2010; Etkind & Shafrir, 2011). Our experience in implementing the approach, ranges from educational systems to industrial organizations and health care services. Specifically these efforts included the Ontario Institute for Studies in Education of University of Toronto (OISE/UT); Faculty of Engineering and Architectural Science at Ryerson University; Russian Academy of Sciences - Ioffe Physico-Technical Institute, St. Petersburg; Independent Learning Center (ILC) of

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