

Chapter 25

Culturally Aware Mathematics Education Technology

Erica Melis

German Research Center in Artificial Intelligence (DFKI GmbH), Germany

Giorgi Goguadze

University of Saarland, Germany

Paul Libbrecht

German Research Center in Artificial Intelligence (DFKI GmbH), Germany

Carsten Ullrich

Shanghai Jiao Tong University, China

ABSTRACT

Education and learning take place in a situation that is heavily influenced by the culture. The learners' cultural context affects cognitive processes in learning. Hence, to improve the conditions for learning, e-learning environments and their contents have to interact with the learner in a culturally appropriate way. Therefore, an e-learning system intended for cross-cultural usage has to adapt to the students' diverse cultural background. For the enculturation of the European platform for mathematics learning, ActiveMath, a number of dimensions are adapted culturally. These are: presentation of system and learning material, terminology, selection and sequencing of learning objects, interaction, and learning scenarios. This chapter describes ActiveMath' enculturation: computational model, computational techniques, and the empirical basis for the cultural adaptation.

MOTIVATION AND THEORETICAL BACKGROUND

One of the grand challenges in European TEL research focuses on technologies for learning that will be designed for culturally diverse and cross and intercultural settings.

Enculturation is not only important for tutoring systems that teach cultural relationship, geography, culture, and behaving appropriately in other countries, etc. such as the cultural training system Alelo¹ but also for mathematics learning environments. At first, mathematics education may seem to be an unlikely field for enculturation.

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However,

- Mathematics education often follows the terminology (notions) of a particular book dominant in the region's education or of a field that applies mathematics, e.g., electrical engineering
- In the region's or field's mathematics education more often than not specific notations is used
- Educationalists and teachers emphasize the cultural context and for teaching mathematics they follow the curriculum prescribed for their region and type of school
- Educational psychologists and pedagogues emphasize the importance of posing authentic mathematical problems, which are relevant in the student's life environment. This aspect is typical for a more constructivist-learning paradigm (Schifter, 1996; Fosnot, 1996).

Theoretical Background

In addition, at the level of cognitive processes Piaget's theory of learning implies that learning heavily depends on the context and experience of the learner. Piaget's influential theory of learning introduces two fundamental cognitive functional processes in learning: *assimilation* and *accommodation* (Piaget, 1947; Piaget, 1977).

Assimilation and accommodation are two complementary processes of adaptation in the learner's mind through which awareness of the outside world is internalized. They are inseparable and exist in a dialectical relationship. In assimilation, what is perceived in the outside world (in the context) is incorporated into his/her mind without changing its structure. In accommodation, the mind accommodates itself to the evidence/context with which it is confronted and thus adapts to it.

An immediate implication of this theory is that the learner's context including its cultural determination is reflected in the learning process (and

in its adaptation efforts). Assimilation requires more effort when the external and internal (mind) features differ more. Accommodation can include adaptation leading to more correct mathematical schemes/mind structures but also adaptation to cultural differences that are mathematically not as deep. Both types of adaptation yield cognitive load, but the cognitive load for a mathematically rather shallow adaptation is extraneous and may hinder learning.

From a theoretical point of view it has also been defined which (different levels of) cultural groups are relevant for enculturation in (mathematics) learning. It isn't only the region/country/language that requires enculturation but also communities of practice (CoP), which can be a group inside another or a group orthogonal to a region/country/language group, e.g., chemistry or electrical engineering students. Wenger (Wenger, 1999) acknowledges that (learning) practices are influenced by context(s) and that the internal dynamics of a CoP including its norms (part of a culture) are determined by the practices such as 'negotiation of meaning' (i.e., understanding of mathematical notions and notations), 'learning', as well as 'community actions' (e.g., book publishing, conferences), and 'differentiation from other communities of practice'. Any CoP produces abstractions, symbols, stories, terms, and concepts that reify something of its practice in a congealed form. Note that even cultural variations whose nature appears to be linguistic such as notations and notions have a cultural (often historical) background. Reasons for such differences can originate from a dominant group of mathematicians in history and cultural ties to that group in certain countries, regions, and groups. A similar development (maybe not yet for mathematics) is observable today for communities of practice, e.g. users of email or SMS.

For cultural differences present in language-defined communities, a reason may be that in mathematics the history of schools, research, teacher education, popular books which influence

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