

## Chapter 4.20

# A Case Study on Scaffolding Adaptive Feedback within Virtual Learning Environments

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### ABSTRACT

Despite a growing development of virtual laboratories which use the advantages of multimedia and the Internet for distance education, learning by means of such tutorial tools would be more effective if they were specifically tailored to each student needs. The virtual teaching process would be well adapted if an artificial tutor (integrated into the lab) could identify the correct acquired knowledge. The training approach could be more personalised if the tutor is also able to recognise the erroneous learner's knowledge and to suggest a suitable sequence of pedagogical activities to improve significantly the level of the student. This chapter proposes a knowledge representation model which judiciously serves the remediation

process to students' errors during learning activities via a virtual laboratory. The chapter also presents a domain knowledge generator authoring tool which attempts to offer a user-friendly environment that allows modelling graphically any subject-matter domain knowledge according to the proposed knowledge representation and remediation approach. The model is inspired by artificial intelligence research on the computational representation of the knowledge and by cognitive psychology theories that provide a fine description of the human memory subsystems and offer a refined modelling of the human learning processes. Experimental results, obtained thanks to practical tests, show that the knowledge representation and remediation model facilitates the planning of a tailored sequence of feedbacks that considerably help the learner.

DOI: 10.4018/978-1-60960-818-7.ch4.20

## 1. INTRODUCTION

Virtual laboratory-based learning is likely to have a profound impact on the whole area of education by affecting the way we learn, what we know and where we acquire knowledge. In the educational community a large amount of enthusiasm has been engendered for highly interactive virtual laboratories, exploiting the multimedia features and the web advantages for a remote teaching purpose and which behave according to laws and constraints of subject-matter domains, permitting the student to experience the nature of those domains through free/guided exploration or scaffolding adaptive learning.

The original notion of scaffolding assumed that a more knowledgeable tutor helps an individual learner, providing him/her with exactly the help s/he needs to move forward. A key element of scaffolding is that the tutor provides appropriate support based on an ongoing diagnosis of the learner's current level of understanding. This requires that the tutor should not only have a thorough knowledge of the task and its components, the subgoals that need to be accomplished, but should also have knowledge of the student's capabilities that change as the instruction progresses.

Considerable success has been achieved in the development of software scaffolding that has been employed within interactive learning environments and virtual labs to offer a means of enabling learners to achieve success beyond their own independent ability (Hammerton & Luckin, 2001). Jackson et al. (1996) showed that an approach which attempts to design adaptable learning environments which offer learners guidance and tools to make decisions for themselves also should address the importance of maintaining the fine balance between system guidance and learner control. However, evidence from other researches into learners' use of scaffolding assistance has indicated that less able and knowledgeable learners are ineffective at selecting appropriately challenging tasks and seeking appropriate quantities

of support and guidance (Luckin & du Boulay, 1999; Wood, 1999). This led, among others, to explore the way that Vygotsky's Zone of Proximal Development (Vygotsky, 1986) can be used in the design of learner models.

To provide appropriately challenging activities and the right quantity and quality of assistance, du Boulay, Luckin & del Soldato (1999) have presented a categorisation which suggests three principled methodologies for developing teaching expertise in artificial tutoring. First is the Socratic tutoring that provides a number of detailed teaching tactics for eliciting from and then confronting a learner with her/his misconceptions in some domain. The second methodology is the contingent teaching which aims to maintain a learner's agency in a learning interaction by providing only sufficient assistance at any point to enable her/him to make progress on the task. The third methodology is an amalgam of the above two. This builds a computational model of the learner and derives a teaching strategy by observing the learner's response to deferent teaching prompts selected with regards to the model. Scaffolding in the form of prompts to help students reflect and articulate has been developed under different types, either by varying the activities according to their difficulty or content of the task (Bell & Davis, 1996; Jackson et al., 1998; Puntambekar & Kolodner, 2005; Luckin & Hammerton, 2002).

Furthermore, it is a generally held position that the process of learning will improve when learners are given virtual tutoring that allow for interactive access tuned to the specific needs of each individual learner. If we aim to develop virtual laboratories in complex domains which are equipped with tutorial strategies able to interact with learners having various levels of intelligence and different abilities of knowledge acquisition, then understanding the human learning mechanism and the manner of structuring and handling knowledge in the course of this process is a fundamental task.

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