

# **Integrating Metacognition Instruction in Interactive Learning Environments**

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## **Declaration**

I hereby declare that this thesis has not been submitted, either in the same or different form, to this or any other university for a degree.

Signature:

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# Integrating Metacognition Instruction in Interactive Learning Environments

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## Abstract

Metacognition is a higher order thinking process responsible for active control over cognitive processes. It is an important ingredient for learning as empirical studies have shown that metacognitively aware students perform better than less aware ones. Theories of metacognition emphasize the importance of self-reflection as a means to improve one's ability to monitor, self-direct and evaluate one's learning processes.

Some ways of including metacognition instruction in Interactive Learning Environments (ILEs) have been suggested. In practice, however, most ILEs overlook it, not least because it is very difficult to provide adequate guidance on metacognition to students.

This thesis puts forth a metacognition instruction model, named the Reflection Assistant (RA), that focuses on the following metacognitive skills: (1) problem understanding and knowledge monitoring, (2) selection of metacognitive strategies, and (3) evaluation of the learning experience. The RA automatically builds a metacognitive profile of the student based on two measures: knowledge monitoring accuracy (KMA) and knowledge monitoring bias (KMB). The KMA measures the accuracy of the student's knowledge monitoring. The KMB detects any systematic bias the student might exhibit in her knowledge monitoring, enabling us to categorize students as *pessimistic*, *optimistic*, *realistic*, or *random*.

We tested the RA model by implementing a full ILE for algebra word problems called MIRA. The experimental version of MIRA included an implementation of the RA while the control version did not. An empirical study conducted with 27 undergraduate students showed that students who performed the reflective activities spent more time on tasks and gave up on fewer problems. Moreover, this group answered significantly more problems correctly than the control group. Evidence of a positive effect of the RA model on the students' metacognition was observed. These results suggest that the RA model was beneficial for the learning process.

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## **List of Abbreviations of Terms Used**

**AIED** Artificial Intelligence in Education

**ILE(s)** Interactive Learning Environment(s)

**ITS(s)** Intelligent Tutoring System(s)

**KMA** Knowledge Monitoring Accuracy

**KMB** Knowledge Monitoring Bias

**MAI** Metacognitive Awareness Inventory

**MIRA** Metacognitive Instruction using a Reflective Approach

**RA** Reflection Assistant (Model)