The Effects of Metacognitive Instruction Embedded within Asynchronous Learning Network on Scientific Inquiry Skills.

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During the last decade, much research has focused on Asynchronous Learning Network (ALN). Although the technology seems to have the potential to enhance students' achievement, empirical findings have been inconsistent. Whereas a few number of studies reported positive effects of ALN on achievement, others have shown no significant differences between ALN and control groups, and still others indicated that ALN students performed less well compared to their counterparts studying under face-to-face interaction (Michalski, 2003).

Why has ALN only limited effects on students' achievement? At least two factors may explain this phenomenon. First, ALN is only one segment within a learning environment, and therefore ALN in itself is not sufficient to enhance learning. Second, and most important, students (and teachers) lack the skills needed to learn effectively in ALN environments. For example, analyzing students interactions in ALN environment indicates that quite often students do not activate metacognitive skills during their learning, and therefore their discourse through ALN is disoriented, unfocused, and not effective enough for enhancing higher-order cognitive processes. These findings raise the need to provide metacognitive instruction within ALN environment. The purpose of the present study is, therefore, to develop metacognitive instructional method appropriate for ALN, and to examine its effects on scientific inquiry skills as compared to ALN with no metacognitive instruction or to metacognitive instruction implemented within traditional, face-to-face learning environment.

What kind of metacognitive instruction would be appropriate for ALN? To address this question, we reviewed empirical studies that focused on the outcomes of metacognitive instruction. On a different line of research Mevarech and Kramarski (1997) and Kramarski and Mevarech (2003) developed metacognitive instructional method, called IMPROVE that significantly improved students' achievement in mathematics. IMPROVE was designed on the basis of current research in cognitive and metacognitive psychology. IMPROVE students study in small groups, using self-addressed metacognitive questions that guide their learning. The series of questions include: Comprehension questions (e.g., What is the problem all about?) ; Connection questions (e.g., How the problem at hand is similar to or different from problems you have solved in the past?); Strategic questions (e.g., What strategies are appropriate for solving the problem and why?); and Reflection questions (e.g., Does the solution make sense? Can you solve the problem differently, how and why?).

In a series of studies, including the above mentioned ones, Mevarech and Kramarski showed the effects of IMPROVE on different kinds of mathematical reasoning, and various components of students' discourse. In these studies, IMPROVE students significantly outperformed students who studied individually. The effects were observed on higher and lower achievers, as well as on different kinds of cognitive levels. Furthermore, the effects were evident immediately after the study, as well as a year later.

Although these studies were implemented in traditional, face-to-face classrooms, we hypothesized that metacognitive instruction embedded within ALN environment would largely improve students' achievement. Furthermore, there is reason to suppose that metacognitive instruction has the potential to enhance not only mathematics achievement, but also science achievement, and in particular scientific inquiry skills that required the activation of metacognitive processes.

Given the above review, we designed an innovative learning environment, called **MINT**, the acronym of the components composed the instructional method: **M**etacognitive guided **I**nquiry within asynchronous Learning **N**etworked **T**echnology. We hypothesized that students' exposed to **MINT** will improve their general and domain-specific scientific abilities.

To address this issue, we investigated the effects of four learning conditions on students' scientific inquiry skills. The four learning conditions are: (a) Metacognitive instruction embedded within ALN, (MINT); (b) ALN with no metacognitive guidance; (c) Metacognitive instruction embedded within face-to-face interaction; and (d) Face-to-face interaction with no metacognitive guidance. In the present study, the scientific inquiry processes included both general and domain specific inquiry skills in microbiology, and the metacognitive instructional method was adopted from IMPROVE.

Participants were 407 tenth grade students who studied in eight classrooms, two classrooms under each condition. Intact classrooms were randomly assigned into condition. All students, under all conditions, studied the unit Invitation to Inquiry. They all used the same learning materials for the same duration of time. The unit Invitation to Inquiry reflects PISA approach regarding science literacy. Students were administered a battery of pretests and posttests that assessed students' scientific literacy, including general scientific abilities and domain specific knowledge in microbiology.

Results indicated no significant differences between conditions at the beginning of the study, but significant differences between conditions at the end of the study. The differences were observed on both posttest measures: general scientific abilities and domain-specific inquiry skills in microbiology. Further analyses showed that MINT students significantly outperformed all other groups, whereas face-to-face with no metacognitive guidance (condition d) acquired the lowest mean scores; no significant differences were found between the other two groups (conditions b and c). The positive effects of MINT were observed mainly on the following cognitive skills: comprehending scientific problems. planning experiment, identifying main variables, suggesting appropriate analyses, and drawing conclusions on the basis of scientific evident.

The findings indicate that MINT makes significant contributions to students' achievement in science literacy, particularly to designing experiments and drawing conclusions on the basis of scientific evidence. The theoretical and practical implications of the study will be discussed at the conference.

References

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