A Study on Assistance in Acquiring Meta-Cognition through Assorting Support Methods for Comprehension

Yoshiki Kawaguchi, Hiromitsu Mori, Manabu Nakamura and Setsuko Otsuki
Graduate School of Information Science, Hiroshima City University, Japan
yoshiki@lake.its.hiroshima-cu.ac.jp, {mondo,otsuki}@its.hiroshima-cu.ac.jp

Abstract

So far, various support methods for comprehension have been studied, each of which has its own strong and weak points. We have developed a practical multi media learning environment for e-learning by assorting these support methods, aiming that the advantages outweigh the drawbacks on the whole. In this paper, we discuss how the assorted support methods work effectively in assisting for acquiring meta-cognition. Especially, it will be shown that the method of the mutual complement by assorting texts, ITS and micro worlds is effective for assisting learners in acquiring meta cognition such as self explanation, reasoning, picture drawing, problem solving, error correction, etc.

Introduction

In learning activities, one of the most important things for learners is to grasp their own state of comprehension. That is, they learn more effectively if they reflect to what extent they have understood. In general, learners examine some of the following items to judge whether they could understand the theme they had just learnt.

1) They can explain the theme
2) They can solve a problem by using the theme.
3) They can draw a picture concerning the theme.
4) They can explain how the answer of the problem concerning the theme is solved
5) They can correct the error in the sentence concerning the theme.
6) They can teach about the theme.
7) They can make a problem by using the theme.
8) They can plan an experiment concerning the theme.

The item 1) means replay of the theme and 2) means the use of the theme. The item 3) means restructure of the theme and 4) corresponds to monitoring the problem solving process. The item 5) means finding inconsistencies between the theme and the statement and 6) means reorganization of the theme by judging the partner’s understanding ability. The items 7) and 8) correspond to a high level knowledge activity of modelling by using all meta-cognition methods from 1) to 6).

In this paper, a support method of meta-cognition from 1) to 6) is studied. In section 2, by explaining examples of assortment of the learner support methods, effectiveness of assortment is showed. Discussion and conclusions are given in section 3.

2. A case study of assistance in meta-cognition by assorting plural support methods

Here, on the domain of elementary kinematics, effectiveness of assorting three methods is investigated. They are a textbook called a media book, an ITS used for Q&A, and a micro-world of a simple pendulum. The media book is a learning environment on WWW, composed of a multimedia textbook and buttons used for calling various learning tools, especially ITS and micro worlds. Fig. 1 is an example of a media book.

First of all, a problem, how the weak points of an ITS are compensated, is explained. The problem comes...
from the limited ability of ITS which functions for solving problems only and doesn't function for understanding a concept that the learner encounters for the first time. In order to complement the difficulty, a textbook and/or a micro-world are used simultaneously. A micro-world is expected to assist in generating a mental model[1] of the unknown object. However, discovery learning in a micro-world needs higher learning skill than systematic knowledge transmission in a textbook. It is not appropriate that learning premises on the assumption that all learners possess the skill. So, using ITS together with the textbook may spoil learners' interest. Then the micro-world can again compensate the difficulty.

Q&A in ITS is composed after qualitative simulation by using results of behavior prediction by QSIM[2]. Qualitative simulation is an inferring method of behavior of physical objects along with discrete time lapse by using the qualitative state transition. A qualitative state of velocity and acceleration is characterized by two discrete values: the qualitative value and its gradient. The former is either one of \( \infty, 0, -\infty \), max values, min values, specific constant to the motion, and the latter is either one of (increase, steady, decrease).

The results of the qualitative simulation are used for composing questions and answers in natural language so that the ITS is able to give/answer questions to/from learners, while the micro world is not. Thus inquiring time points when a variable reaches an extreme point, gradient values of a variable in a qualitative time, reasons of the behavior, etc. is composed and answered automatically. Fig. 3 shows a Q&A interface. ITS can judge the learner's answer to the behavior prediction problem given by ITS. For this assistance in acquiring meta-cognition, the assortment of plural support methods is of cause effective, e.g. for incorrect answers, recommending learners to operate a micro-world to find the correct motion, explaining learners the reason why the correct results are predicted, or recommending learners to consult the textbook. Fig 1, 2 and 3 are an example of assortment.

On the other hand, if the answer is correct, the further prediction from the result can be the next problem to the learner to obtain deeper comprehension.

A micro world has other characteristics of visualizing invisible variables like force, velocity and acceleration. Thus it can recommend learners to draw a resultant or components so that it prompts a learner to reorganize knowledge. It is also important for learners to find out and correct their own errors by comparing their statements or drawings with the behavior of the pendulum.

Thus, learning becomes more effective if an assortment of ITS and a micro-world with a textbook.

3. Discussion and Conclusions

Three support methods have been assorted to investigate the mutual complementary effects. The important paradigm of support methods other than ITS, micro-world and textbook is CSCL. The method has a characteristic of acquiring comprehension through discussion between plural learners via network cooperatively. That is, through discussion, a learner who has firstly met the theme is expected to learn knowledge concerning the theme from other learners who have already met and understood the theme. Learners who take a role of teaching are able to assist themselves in acquiring meta-cognition by re-organizing knowledge for teaching by themselves. Writing reports on the theme may also be effective for the same aim.

[References]
