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An Intelligent Meta-Learning Support System Through Presentation

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Abstract: As described in this paper, we propose a presentation-based meta-learning scheme. Firstly, we present support functions that we embed into the system. Secondly, we conduct experiments to verify the meaningfulness of our learning scheme, which suggests the system can stimulate learners' reflection on their learning processes. Furthermore, it can stimulate learners' meta-learning communications. Results show that users tightened their criteria to evaluate their own learning processes and understanding states. It is useful for learners to facilitate change in their learning processes.

Keywords: meta-learning, meta-learning communication, presentation-based learning

I. INTRODUCTION

Research into computer-supported systems to enhance meta-cognitive skill is investigated by many researchers [2, 3, 4, 5]. Results show, particularly in the educational psychology field, that an emphasis on meta-cognition must accompany domain-specific instruction in each of the disciplines, but not generic instruction in a general context, because the type of monitoring that is required will vary [1]. In a history course, for example, a student might be asking herself in an internal self-conversation, "who wrote this document, and how does that knowledge affect the interpretation of events," whereas in a physics course, the student might be monitoring her understanding of the underlying physical principle at work [1].

Our research goal is the enhancement of meta-learning through stimulation of learners' reflections on their own learning processes. To achieve this goal, we assign a task to make a presentation material on a specific pre-learned topic for other learners whose academic abilities are similar to those of the learner.

Collaborative learners with no regulation, however, might stray in undesired directions: in the case of our presentation-based learning, for instance, they tend to discuss illustrations of the slides, the impact of the presentation, and so on.

We therefore propose a support system that facilitates meta-learning communication by providing learners with viewpoints to discuss their learning methods.

II. Embedding Support Functions to Facilitate Meta-learning Communication

In our research, we developed a presentation-based meta-learning scheme whereby learners can specifically examine learning on their own learning processes. Learners in our learning scheme perform learning by following three steps.

i. Learning specific domain contents through self-study or attending lectures until they think they have understood them
ii. Making comprehensive presentation materials to teach other learners who have the same academic level
iii. Collaborative learning using presentation materials

In the following, we explain support functions embedded into the system at (ii) and (iii) phases to facilitate meta-learning, although phase (i) is beyond our support.

1. Intention Structure Reflecting Learning Contexts

To encourage meaningful meta-communication among learning partners, each learner must (A) become aware of performing meta-learning and (B) share individual learning contexts. In our learning system, providing a representation to describe their intention of the presentation, intention structures and guidance function according to them play roles of enhancing their awareness at the presentation design phase.

At the presentation design phase, we make learners construct intention structures to be aware of learning skill acquisition. Giving appropriate instructions

according to learners' learning contexts is significant to facilitate their learning skill acquisition processes.

In our task setting of making truly comprehensive presentation materials for use by those who have the same academic level with the presenter, we adopt an assumption that intention structures of presentation reflect learners' learning contexts in their learning.

In the intention structure (Fig. 1. (iii)), each node represents an educational goal and terms to represent them are provided from the system to represent the learners' educational goals.

2. Guidance Function to Enhance Meta-Cognitive Awareness

Guidance information to facilitate the learner's reflection on personal learning processes is provided when the learner intends to move to the subsequent collaborative learning phase. It represents queries on domain-specific learning activity based on the learner's intention structure. The teacher giving a presentation subjects also constructs an intention structures and indicates required learning (teaching) activities on them that should be embedded into learners' intention structures. The system cannot understand the contents of learners' presentation written in natural language. However, it can process intention structures by referring learning skill ontology. Therefore, if learners did not embed them, then the system provides queries by referring domain-specific learning skill ontology and the teacher's intention structure as follows:

(1) "Do the following learning activities need to be included in your presentation to achieve the learning goal "make the learners understand DP using Abstract Factory pattern as an example?" Choose "embed into presentation" by right-mouse clicking if you think you need to do so.

(2) "Do you have sufficient understanding of these teaching activities? Check the items you had already understood."

- ☐ Make the learner understand the meaningfulness of the fact that each DP has its own name.
- ☐ Make the learner understand the advantages of object-oriented programming by combining its general theories with concrete examples in the Design Patterns.
- ☐ … (Required learning activities defined in learning skill ontology are listed)

The learner is required to examine the importance of each learning activity for constructing comprehensive presentation materials: the learner judges whether the learner's presentation is valid or not and whether each learning activity should be included in the learner's presentation. This guidance is a stimulation to facilitate the learner's reflection on personal learning processes.

The fact that the learner did not embed listed learning activities is interpreted as follows: (a) the learner has no learning activities as domain-specific learning operators in his own consciousness, (therefore the learner cannot perform them) or (b) the learner does not understand the importance of the learning activities even if they have and they had performed their learning processes. The learner's checking activity in query (2) is interpreted as a declaration of whether the learner has them as learning operators.

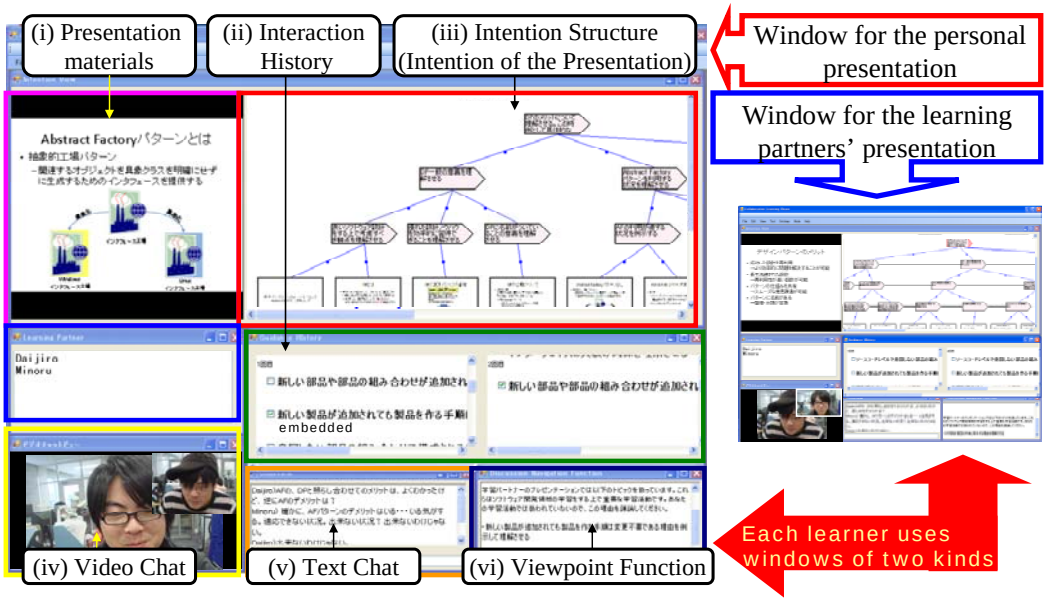

Figure 1. CSCL Environment to Facilitate Meta-Learning Communication.

For (a), the learner must perform the learning activities spontaneously or must be taught from the learning partners at the collaborative learning phase. For (b), the learner must encourage internal self-conversation to consider the importance of each learning activity.

The guidance function plays a role of building a foundation to encourage meta-learning communications among learning partners by stimulating their awareness in meta-learning before starting collaborative learning.

3. Viewpoint Function to Stimulate Meaningful Learning Communications

Figure 1 portrays a screen image at the collaborative learning phase. The window comprises six panes: the presentation pane (Fig. 1 (i)), interaction history pane (Fig. 1 (ii)), intention structure pane (Fig. 1 (iii)), video chatting pane (Fig. 1 (iv)), text chatting pane (Fig. 1(v)) and discussion viewpoint pane (Fig. 1 (vi)). The system is implemented in Visual Basic and Java, functioning cooperatively with Power Point (Microsoft Corp.).

The system in the collaborative learning phase provides support of two kinds to facilitate learners' learning skill acquisitions (acquiring learning operators and tightening evaluation criteria) as follows.

(1) Support to share learning (teaching) contexts of learning partners by referring to presentation materials with intention structures.
(2) Facilitate meaningful discussions to encourage their reflections on their own learning processes by providing discussion viewpoints.

As described in this paper, we particularly examine the topics on the viewpoint function.

Thinking processes related to one's own learning processes are quite tacit. Therefore it is not easy to externalize and to discuss learners' thinking processes (while teaching processes reflecting their learning processes are externalized as intention structure). Ordinary learners with no support tend to discuss the appearance of illustrations, animations, and so on.

To eliminate the problem, our system provides viewpoints to discuss their teaching and learning methods based on the interaction history between the learner and the system at the presentation design phase. As shown in Fig. 1 (vi), the system provides each learner with respective viewpoints to discuss as follows: "You judged the learning activity "Make the learner understand the significance of the fact that an interface specifies the name of each method by taking an example." as important. It is an important learning activity in the software development domain and you embedded it into your presentation. On the other hand, your learning partner judged it as not important. Explain why you think this learning activity is important."

Collaborative learners can discuss their domain-specific teaching methods by referring to the viewpoints for meta-learning communication.

III. Experimentation

We conducted an experiment to verify the meaningfulness of our learning scheme and usefulness of support functions embedded into the system. We specifically examine the issues of whether the system can encourage meta-learning communications. The outline of the experimentation is described below.

- ✓ **Subjects:** 16 graduate students participated. They had completed software engineering (UML) and object-oriented (Java) programming courses when they were undergraduate students. They were divided into two groups at random: eight students were in the experimental group (ExpG) using the system; eight were in the control group (CtlG).
- ✓ **Presentation topic:** Make presentation materials explaining the merits of building design patterns by taking the abstract factory pattern as an example.
- ✓ **Flow of the experiments:** Continuous 7 days lecture (90 min lecture each day) without weekend:

Table 1 presents results of questionnaires after their collaborative learning. Questionnaire items 1 is related to the usefulness of the presentation-based learning scheme and 2–3 are related to learning effects from the viewpoint of meta-learning.

Regarding item 1, participants in both ExpG and CtlG gave quite high marks, which suggests the presentation based meta-learning stimulates learners' reflection on their learning processes.

It is expected that learners will execute better learning processes using the acquired domain-specific learning activities and tightened evaluation criteria if the learners' meta-learning processes are performed successfully. Items 2–6 inquired the about learners' consciousness of them. Both groups gave high marks to each item. However, CtlG gave higher marks than ExpG for the acquisition of domain-specific learning activities (items 3 and 5), whereas ExpG gave higher marks than

Table 1. Results of Questionnaire after the Collaborative Learning Phase

Questionnaire Items		ExpG		CtlG	
		Mean	SD	Mean	SD
1	Do you think the collaborative learning after making your presentation materials enhanced your reflection on your own learning processes?	4.375	0.267	4.375	1.982
2	Do you think collaborative learning changed your criteria to evaluate your understanding of DP?	2.875	1.553	3.375	1.982
3	Do you think you could acquire learning methods using collaborative learning?	3.375	0.839	3.625	1.41
4	Do you think your learning processes for other DPs will change after performing this presentation-based learning?	3.75	1.071	3.5	1.428
5	Do you think you could acquire learning methods by performing this presentation-based learning?	3.625	0.553	4.125	0.982
6	Do you think your consciousness of learning will change by performing this presentation-based learning?	4.1	0.238	3.875	0.982

CtlG for items related to the consciousness of changes of their own future learning processes (items 4 and 6). Those responses seem to be mutually contradictory. However, they are not so by the following interpretation: learners in ExpG had tightened their learning criteria to evaluate their learning processes and understanding states; thereby, they also strictly evaluated their meta-learning processes. The results of the average time ratio of meta-learning communication support this. However, the fact that participants in ExpG gave low marks related to item 2 suggests that they were unable to perform all meta-learning processes by themselves even though they were able to understand the importance of meta-learning. They might be conscious of the functions. Actually, we do not embed the functions that support performance of learning activities acquired by meta-learning processes even when the system triggers learning activities. On the other hand, participants in CtlG spent less time for meta-learning communications, suggesting that the learners' evaluation criteria had not been tightened through their communications. Consequently, their evaluation results for these items were more tolerant.

IV. CONCLUDING REMARKS

As described in this paper, we present discussion of a presentation-based meta-learning scheme. We introduced our presentation based meta-learning scheme. Then, we conducted an experiment to verify the meaningfulness of our learning scheme and usefulness of support functions embedded into the system, which suggests that the system was able to stimulate learners' reflection on their learning processes. It stimulates learners' meta-learning communications. Consequently, they tightened their criteria to evaluate their own learning processes and understanding states. It is meaningful for the learner to change their learning processes. We also evaluated their learning outcomes of domain dependent knowledge: it suggests participants in ExpG could get higher mark than ones in CtlG. We will carefully address the issues of this in future works.

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