Meta-cognitive Skill Training by Serializing Self-Dialogue and Discussion Processes

Kazuhisa SETA[a*], Liang CUI[b] Mitsuru IKEDA[b] Noriyuki MATSUDA[b] & Masahiko OKAMOTO[d]

[a] *Faculty of Science, Graduate School of Osaka Prefecture University, Japan*
[b] *School of Knowledge Sciences, JAIST, Japan*
[c] *Faculty of Systems Engineering, Wakayama University, Japan*
[d] *School of Humanities and Social Sciences, Osaka Prefecture University, Japan*
*seta@mi.s.osakafu-u.ac.jp

Abstract: The authors hold the opinion that to acquire a skill for co-creating knowledge with others cooperatively, development of meta-cognitive skill is important, but to do so is not straightforward. Herein, we attempt to design thinking skill (particularly meta-cognitive skill) development curriculum for first year bachelor students based on the results obtained by two preceding studies we have performed so far for postgraduate education and those engaged with medical services. To deal effectively with new learning for first year bachelor students---"Thinking about thinking"---we designed a curriculum by which students are given knowledge co-creation program and thinking externally tool to devote attention to thinking process and to have bodily sensation of its meaning, and put it into practice. This paper describes learning model for thinking skill which is fundamental to appropriate curriculum designing and discusses design intent of the curriculum conforming to it and usefulness of the learning program through examples of practice using thinking externally tool. Results show that the learning program developed in this study is useful for cultivating meta-cognitive skill of bachelor students.

Keywords: Thinking externally, meta-cognitive skill, knowledge construction workshop

Introduction

We aim at developing a thinking education program by which students can notice the importance of directing their attention and own thoughts through lectures and practices in a small group seminar held for half year in the form of public lectures and can realize their meaning for their productive learning during university life [1-4].

New learning for bachelor students confronting the "Thinking about thinking" thought process should be conducted effectively using the following two items: (1) The education curriculum is such that aggressive association with others (presentation, discussion) contributes to training of thinking. (2) Topics adopted for bachelor students who have not gained high expertise yet and who have non-uniform interests of learning should be suited for training of thinking, differences of existing knowledge for particular area should not give negative influences on the degree of participation and motivation for learning to the greatest extent possible. Moreover, after completion of a half year program, the curriculum should urge them to set independent setting of opportunities for training of thinking while they use various experiences and events gained and encountered during university life as learning materials for their thinking.

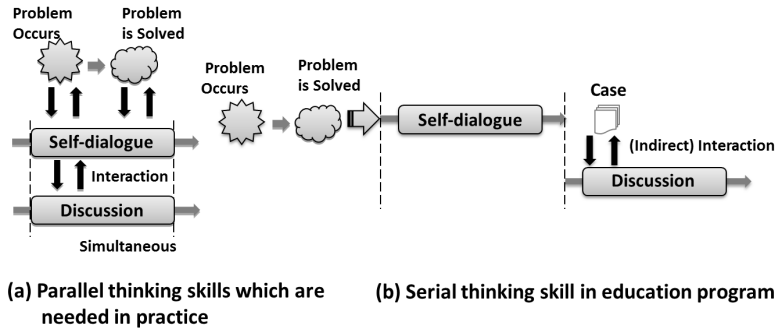

Figure 1. Reducing the Difficulty of Learning Thinking Processes

1. Learning Model of Thinking Skill

For beginners of discussion and many bachelor students, simultaneous interaction of self-dialogue and dialogue with others is an extremely difficult task. Figure 1(a) presents this situation. Thinking of dialogue with others and of self-dialogue are in parallel within the time until settlement of the problem to be solved. Therefore, the cognitive load of learning in parallel with that is remarkably important.

When it is regarded as educational program, to relieve cognitive loads, parallel cognitive activity should preferably be made sequentially, as shown in Figure 1(b). In addition, such a design of education is necessary that interaction can be reconstructed under conditions in which thinking of self-dialogue and of dialogue with others are made in parallel, based on matters learned from the sequential process. We consider that sensing isomorphism between *self-dialogue thinking* and *dialogue with others thinking* is important for the learner to reconstruct the abundant interactions between two thoughts and to accomplish knowledge co-creation. For this reason, in the knowledge construction workshop explained later, educational materials are designed including such a policy that students are encouraged to be aware of the isomorphism.

Educational advantages of our model are that first, thinking of self-dialogue could be learned from thinking of dialogue with others and second, thinking of self-dialogue acts as simulation before the discussion, reduces loads at the discussion, and generates a margin for cognitive resources to be assigned to knowledge co-creation processes and meta-cognitive learning.

2. Outline of Learning Curriculum

Targets of learning

The following learning targets were set in our research:

Major target: They become aware that for appropriate execution of dialogue with others, self-dialogue should be performed appropriately. They also notice that for appropriate execution of self-dialogue, dialogue with others should be performed appropriately. To do so, we set the following three **subordinate targets**:

1. To deepen understanding of knowledge construction method through practice of communicating something to others.
2. Students notice the importance of multiple thinking through a knowledge construction workshop and notice that it should be applied equally to self-dialogue and dialogue with others.

3. Students feel bodily that the depth of one's own learning will have marked influences on the quality of explanation to others.

Table 1: Contents of every program of thinking learning performed

One notices that performing dialogue with others properly requires a proper self-dialogue (to be dealt with later). Also, performing self-dialogue properly requires proper dialogue with others.		
To understand knowledge construction method sufficiently through teaching of others.		
	1st: April 11	Explanation of points of the lecture, self-introduction, and introduction of meta-cognition concept
	2nd: April 18	Setting of learning target (Big target, medium target), Practice of manipulation of Power Point
	3rd: April 25	Practice of pyramid principle (1), Practice of manipulation of presentation tools
	4th: May 2	Practice of pyramid principle (2)
	5th: May 9	Creation of presentation of knowledge construction method
	6th: May 16	Presentation and discussion of knowledge construction method
One notices the importance of multiple thinking through the knowledge construction workshop and notes that its execution should be identical in mental dialogue and dialogue with others.		
	7th: May 23	Presentation of knowledge construction method by the teacher, explanation of Sizhi system roles
	8th: June 6	Practice of Sizhi system operation, Thought description related to case example 1
	9th: June 13	Knowledge construction workshop of case example 1, Re-description of thinking after workshop completion
	10th: June 20	Commenting on knowledge construction workshop of case example 1. Exemplification of knowledge construction case example by the teacher. Case example 2 is distributed and thought description is given as post-lesson theme.
	11th: July 4	Knowledge construction workshop of case example 2. Re-description of thoughts after completion of discussion.
	12th: July 11	Execution of demonstrative workshop (Replies to appreciation theme).
Students feel bodily that the depth of one's own learning will have marked influences on the quality of explanation to others.		
	13th: July 25	Re-creation of presentation of knowledge construction method
	14th: August 1	Discussion to deepen understanding of the knowledge construction method is held again and reasons for improvements from previous ones are discussed
	15th: August 8	After videotape of demonstrative workshop is shown again, thoughts of discussion participants are presumed.

To achieve proficiency of "thinking about thinking" meta-cognitive skill, long-term training is necessary. It is impractical to expect bachelor students, who are only recently graduated from high school, to master meta- cognitive skill after being given only half-year lectures. Implementation of thinking education programs for long periods is also impractical. The purpose of the current study is to direct students' attention to thinking by letting them contact one thinking method designated as knowledge construction method: "To sow a basis for cultivation of learning readiness". We regard such a curriculum as important to nourish personal thinking/learning style by themselves. Students will be able to understand the meaning of deep mining of any problem, no matter how trivial, and accumulate various experiences to direct their attention to the thought.

2.2 Designing of a learning curriculum

We investigated attainment measures for each subordinate target and designed a curriculum. Accomplishment of subordinate target 2 is regarded as the core, whereas subordinate target 1 is the preparatory stage for deepening understanding about the knowledge construction workshop (as explained in later) as the means for it, and accomplishment of subordinate target 3 is ranked as the summary stage.

For accomplishment of subordinate target 2, a learning environment or curriculum using the external thinking tool will be described mainly in this paper. Table 1 presents

contents of the thinking learning program curriculum. To accomplish subordinate target 2, the external thinking tool "Sizhi", which is explained in detail in 3, is used.

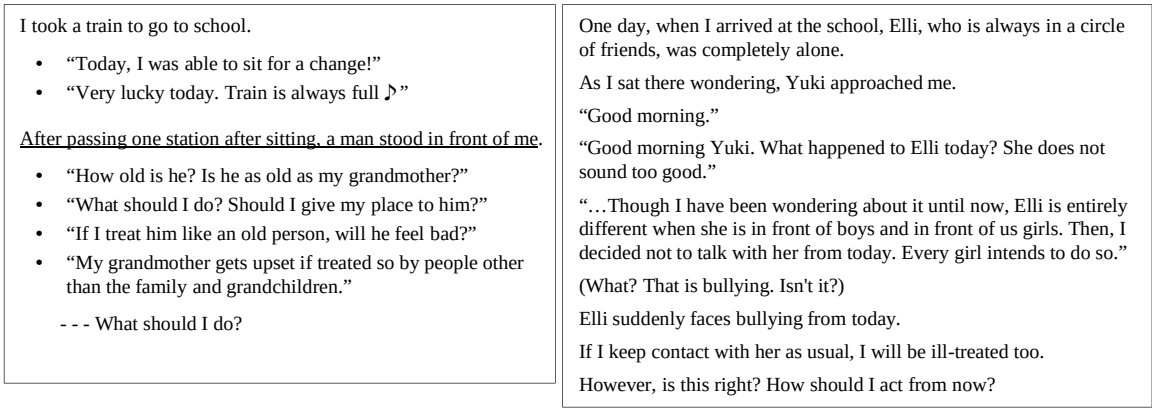

Figure 2 Theme Example (Left: Offering one's seat (Case 1), Right: Bullying case (Case 2).

According to the matters stated in the introduction, the following items were used as guidelines in the current study:

(A) Topics reflecting the structure of verbalization model of thinking, i.e., those retaining opposing structure and entanglement of thought, should be set.

(B) Daily topics that are not influenced by existing knowledge for particular area should be set. In the current study, routine topics which demand no special knowledge for knowledge construction are used.

Item (A) allows task-setting, which necessitates sorting of the thoughts. Item (B) reduces loads exerted to domain learning. It is advantageous with regard to securing cognitive resources to be assigned to thinking learning. Two case examples of task incorporating entanglement structure are given as shown in Fig. 2. Case examples 1 and 2 incorporate the following entanglement structure:

- **Case example 1**: [Be cautious not to injure grandfather and not to hurt his feelings. Be cautious not to get offended.] and [To mitigate grandfather's physical burden and give him pleasure.]
- **Case example 2**: [Be cautious not to be get teased oneself (to be safe oneself).] and [Do right things by your own judgment.]

With self-dialogue, learners are requested to verbalize [5] the conflicting structures shown above definitely by their own thoughts, to sort them out, and then to remove them and to perform knowledge construction. Furthermore, to urge learning by discovery from comparison and observation of one's own self-dialogue and the same of others, for the same case example 1 which learners undertook, contents of thinking written by the learners are reviewed and commented upon. Description by the teacher is presented using examples to give illustrative explanations of meta-thinking of the teacher.

After completion of the knowledge construction workshop two times by the learners, learners are requested to observe the demonstrative workshop performed by the teacher for case example 2 to urge learning by discovery from comparison and observation of discussion which learners performed and from model discussion of others.

In formulating the demonstration scenario, the principle of good dialogue with others resulting in knowledge construction should be embedded implicitly, although explicit wordings such as [to esteem opinion of others], [to consider perspectives of different people (from discussion participants)], [to consider the perspective of another stakeholder (from discussion target themes)], [to consider whether naive recognition of right and wrong is truly correct] and [to consider after the problem is generalized] are not expressed.

Learners are then requested to tackle an appreciation theme (stated in 4) for discovery and pointing out of good points of thinking.

Figure 3 Self-reflection tab in knowledge description tab (Left) and Conflict tab in Cognitive conflict tab (Right)

3. Sizhi: learning environments of the self-dialogue thinking process

The purpose of training of thoughts in individual thinking and group discussion is to create a new knowledge, to identify conflicts between one's own thought and others and to enable everyone to talk logically under any circumstances. Sizhi is a tool to realize this. Figure 3 presents thoughts of self-dialogue expressed by Sizhi, and presents the thought description of the learner. As shown there, the statement is composed fundamentally of numbers assigned sequentially, tags expressing the thought that created said statement, and descriptive sentences. Some statements provide a basis for judgment of the statement showing the basis of why it is introduced.

In all, 10 tags, fact, premise, principle, assumption, judgment, presumption, result, reflection, construction, and settlement are set. An important matter for the thinking process of self-dialogue to result in quality knowledge construction is that it is free from superficial entanglement and conflict and is able to detect fundamental entanglement and conflict. Therefore, the first important issue in designing Sizhi is to urge the learner to clarify thinking steps by the tag and to review thinking steps to find the root of entanglement and conflict.

The purpose of the tab is to demonstrate the whole thinking process simply and structurally to the learner and its structure is such that a more detailed thinking process is included in the tab which expresses three phases of knowledge construction process. Figure 3 depicts such a situation in which the learner selects the learner's own review in the knowledge statement tab. The thinking tag for expressing one's own thinking steps is used in the description of the thinking step.

Consequently, Sizhi is designed such that for hidden and formless thinking of thinking activity that supports knowledge creation and for the chaotic thinking process, the tag for elucidation of each of thinking steps (Sizhi tag) and tab (Sizhi tab) for reminding cognition of the thinking phase are presented to the learner to urge the learner to think externally along with said process and to study it closely.

4. Experimental Study and Evaluation

Contents of practice of the lesson along with the curriculum designed in section 2 above and its usefulness are discussed. The 7th to 12th knowledge construction workshops are regarded as the central part of the lesson. Here, the contents of the teaching performed

mainly at the knowledge construction workshop and its assessment are described referring to Table 1.

4.1 Practice of knowledge construction workshops

- **7th:** Explanation for the knowledge construction method was given by the teacher. The roles of the Sizhi system in it were explained.
- **8th:** The Sizhi tool screen was projected using a projector. The teacher showed operations using sample examples. Then the learner exercised operations. Subsequently everyone described the thinking I used as the learner in case example 1 – offering my seat to others – on Sizhi.
- **9th:** Groups each consisting of three people discussed case example 1. Subsequently thinking was restated on Sizhi to review the self-dialogue.
- **10th:** The teacher commented on the knowledge construction workshop and the thought description performed by the learners at the 9th workshop. The Sizhi system was shown using the projector and the teacher explained the contents of thinking. Here, in comparison with the thinking described on Sizhi by the teacher, the following five items were exemplified as meta-knowledge reminding multiple thinking:
  (M1) For consideration from another person's perspective instead of the perspective of the person concerned. For example, such a case is applicable when considering *how grandfather would consider it from his perspective*.
  (M2) For consideration while the time axis for problem solving is widened. For example, such a case is applicable when considering *if I were grandfather, how I should do it*.
  (M3) For consideration from a perspective of improving the social system. For example, such a case is applicable to this when considering *who would become happy*.
  (M4) For consideration if common sense, unsophisticated sense, and own thinking are really correct. For example, such a case is applicable to this when considering *if not getting assistance from young people is really a virtue*.
  (M5) For consideration while presuming and analyzing composition of human mind. For example, such a case is applicable to this when considering *if an increase in the number of [priority seating] is effective for problem solving and what does "feeling to be safeguarded by society" mean*.

Furthermore, case example 2 was distributed and a thought description for this was given as the task other than the lesson.

- **11th:** Groups each consisting of the same three members as the last time discussed case example 2. Subsequently, thinking was restated on the Sizhi system to review self-dialogue.
- **12th:** Two of the authors and one graduate student held a demonstrative discussion about case example 2. In this case, two questions shown below and a description in the memo column are printed on an A4-size sheet and distributed. The learners confirmed the problem, appreciated them while taking notes and upon completion, replied to the following two questions. [Q1] Mention three points for which you think the discussion was good. [Q2] For each of the points described in [Q1], infer what they were thinking and describe them.

4.2 Evaluation of learning program

Table 2 Results of Q1

Q1	Category I	Category II
ExpG	9	0
CtrlG	6	4

Table 3 Results of Q2

Q2	Category I	Category II
ExpG	8	1
CtrlG	4	6

In this study, nurturing of meta-cognitive skill is intended. However, we realized that to expect drastic increase of meta-cognitive skill to bachelor students by only a half-year lecture is an overly ambitious learning target.

It is considered that the target [To seed for foundation for cultivation of stance ready for learning] stated in section 3 means that the opportunity of performing thinking of self-dialogue and dialogue with others could be used even after completion of the program as the opportunity of learning thinking. Here, a demonstrative workshop appreciation theme is selected and the usefulness of this program will be discussed qualitatively, devoting attention to differences of replies by students who took the learning program (experimental group, 9 students) and by bachelor students (control group, 10 students) who did not take it.

The experimental group replied twice for the same theme on July 11 and August 8 (videotaped) during the lecture. This time, the first of July 11 will be discussed as the comparison target. A videotaped demonstrative workshop held on July 11 was shown to the control group on August 9 after completion of the first semester.

The appreciation theme [Q1] shown in 4.1 measured whether meta-cognitive activity of others is recognizable from the remarks of participants in the demonstrative workshop and appreciation theme [Q2] assumed why the others took such meta-cognitive activity and measured whether they were able to understand why the others took such meta-cognitive activity. Therefore, with this theme, the former could respond as long as they have meta-cognitive knowledge, although the latter were unable to respond unless usefulness of the meta-cognitive activity concerned is understood. In this sense, it is considered that appreciation theme [Q2] ensures deeper meta-cognitive understanding.

To analyze differences of responses to appreciation themes [Q1] and [Q2], responses were classified into three categories: I, Description of how to discuss and directionality of resolution; II, Description of own understanding and opinion relating to target of the discussion; and III, Others. Category I is a meta-cognitive description related to how to discuss and directionality instead of discussion contents. For example, it includes [One case is considered from several viewpoints or cases] and [Conflictive point is listed for every opinion to identify point of argument]. Category II is a description relating to own understanding and opinion about contents being discussed in the workshop and does not include meta-cognitive activity. For example, it includes [Bullying side has points to be examined] and [Eradication of bullying is not possible]. Those not included in these categories are classified into category III. Regarding category classification, two raters performed rating independently and agreement rate was calculated as 86%, and these classification results were then judged to be appropriate. Because the agreement rate is so high, classification of one rater was used for the data.

Table 2 presents the number of the participants for the case with more than two responses are meta-cognitive mention of category I, of three responses of appreciation theme [Q1] and the number of the participants whose meta-cognitive mention is 0 or 1. Fisher's direct probability was calculated for these data and significant trend was shown ($p<0.086$). This result reveals such a tendency that many people in the experimental group performed meta-cognitive description.

Similarly, Fisher's direct probability was calculated for appreciation theme [Q2] (Table 3). A significant trend was shown ($p<0.057$), which reveals such a tendency that many people in the experimental group performed meta-cognitive description.

Based on these results, it is considered that students in the experimental group who took the learning program can mention many remarks which determine mode of discussion and directionality and are also able to mention many remarks for the reason why such remarks are presented.

As for appreciation theme [Q1], a response is possible if meta-cognitive knowledge of M1–M5 taught by the 10th program are stored in learn-by-heart fashion. However, for appreciation theme [Q2], one is unable to respond unless he is aware of the usefulness of meta-cognitive thinking. Based on this understanding, it might be considered that the learning program shown in the current study will promote understanding related to meta-cognitive thinking of the students who took the learning program to a certain extent.

In addition, responses to the second appreciation theme conducted by the experimental group were analyzed using McNemar's test, which revealed no difference between theme [Q1] and theme [Q2]. It might be inferred that the students of this program already acquired meta-cognitive skill of a certain level at the point of time when they tackled the first appreciation theme.

5. Discussion and Concluding Remarks

The current study is closely associated with cooperative learning and argument study. Novelty of our learning program considered from cooperative study viewpoints is such that before dialogue with others, the learner is requested to perform knowledge construction although the conflict structure is verbalized clearly [5], using thinking externally environments in which the process to be sorted out is incorporated explicitly, and where self-dialogue is performed carefully by assigning the Sizhi tag. This acts as a simulation of dialogue with others and provides a framework for reducing the loads at discussion.

The description level of the meta-cognitive monitoring theme, particularly the abstraction level of language description [6] differs greatly between students who took this program and the control group. Many control group descriptions are closely related to concrete remarks, whereas the experimental group presented many descriptions using vocabularies such as generalized problem and conflict, policy (tag appearing on external thinking tool), which are separated from concrete remarks in [Q1]. It is considered from this that this learning program reminds acquisition of these concepts. How this contributes to the acquisition of meta-cognitive skill is an interesting future theme.

This paper stated a design rationale and practice contents of the meta-cognitive skill cultivation program intended for university bachelor students and presented discussion of its usefulness. A framework that requires no specific expertise in selecting topics for theme-setting incorporating conflict after thinking model is specified can be handled with ease in developing educational materials for bachelor students and can enable systematic teaching based on the model.

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