Reflective Case-Writing Environment using a Multi-representation Schema for Medical Service Education

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Abstract — **In this research, by developing a learning support system for medical services, we will establish an approach that supports medical profession novices to improve proficiency understanding patient-centered medical services. Using an ontology in this paper, as a first step of the project, we organized a learning model which promotes reflective learning of the case-method for medical service education. As an implementation of the learning model, we established a learning environment that support learners to reflect on their thinking process in their experiences by a learning strategy which consists of three case-writing phases: the description phase, the cognitive conflict phase, and the knowledge building phase.**

Keywords-Thinking skill; Case-Method; Ontology; Medical Service Education.

I. INTRODUCTION

There are always many difficult problems continually appearing from various viewpoints in medical practice. Actually, medical staff always feels a vague anxiety that their dedicated efforts could not catch up with the increasing problems. Moreover, to provide high quality medical services that can respond to the various and high-degree increasing patients' demands is becoming an important and urgent issue in medical service practice. The subjects in medical service education in a broad sense include both the medical knowledge/skills for the medical diagnosis or the treatment and the interpersonal skill to facilitate the prompt and smooth implementation of medical services. In this research, we focus on the latter as the matter of medical service sciences in a narrow sense, while we address the former as the matter of "medical education" and will not be deeply involved in it.

We believe that the service science approach can make a contribution to establish a methodology to improve the quality of Medical Services in a narrow sense. One of the pioneers in the field of Service Science, Yoshikawa has proposed that the model for service improvement is that the knowledge circulation of intellectual collaboration by the persons concerned in the service promotes to create and refine the service knowledge. Moreover, he implies that the knowledge circulation will cause the ideal of societal innovation [1]. In the medical viewpoint, we think it is necessary to refine the education approaches for supporting the medical knowledge circulation by improving the medical practitioners' thinking ability to collaboratively create and refine a medical service knowledge.

In this research, by developing the learning support system for medical services, we will establish an approach that supports the medical profession novices to improve their proficiency in understanding patient-centered medical services. The current goal of this research is to make a rational learning model for medical service education and try to establish a methodology to create design loop for medical service educational program development but not to make strong contributions to technological medical service education.

II. DIFFICULTIES IN MEDICAL SERVICE EDUCATION

In recent medical practice, the traditional apprenticeship-style on-the-job training system, so-called of, "seniors train novices strictly on the job" is vanishing gradually because of mental resistance for novices to accept the evidence-lacking, experience-based guidance of implicit medical service knowledge from seniors. Moreover, newcomers who have poor insight and sensitivity to people are increasing, and there appears to be an increasingly pronounced tendency for the medical staff to be unable to learn medical service knowledge or skills to understand patients' minds through communication with other medical staff.
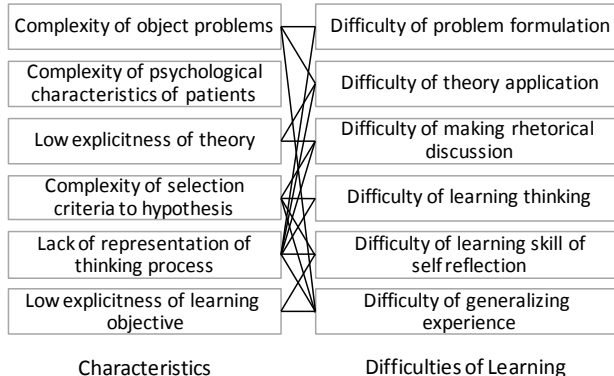

Figure 1.   Characteristics of medical service and difficulties of learning the knowledge required for it

For example, when a novice nurse takes charge of pediatrics, he may be puzzled by the complexity of emotional engagement between the child patients who are weaker than himself, their parents who are exceptionally

anxious about their children's health and the doctors who conduct medical treatment. In order to have an acute insight into the complex structure of emotional engagement, it is necessary to have a rich sensitivity for understanding others' minds and, a rational attitude of the acceptance of and respect for the immature hearts of the pediatric patients. That is typical tacit knowledge which is not easy to acquire for novice medical staff.

For the purpose of developing medical human resources with higher cognitive ability as shown in Figure 1, a variety of educational methods to foster the tacit knowledge or tacit skill by coaching the thinking process has been offered to the medical staff. For example, in the field of nursing education, teaching approaches such as clinical conferences, reflective journals, narrative methods, case-method, etc. are conducted on a routine basis at many hospitals. However, in such a practical learning environment, it is said that the major difference between the learners who can learn what should be learned and the learners who cannot learn very well comes from differences in learners' sensibility or insight to others' minds. Moreover, even though learners have successfully taught tacit knowledge in the practical learning environment, most of them face more serious difficulties to assimilate the knowledge to their own existing knowledge and organize it as general knowledge to be applicable to future similar situations. The difficulties are caused by lack of the experience of making "thinking about others' minds" a subject for meta-level logical thinking, while most people guess others' minds only by intuition. Therefore, to foster the ability of meta-level logical thinking seems to be accompanied by an essential difficulty caused by the essential nature of humanity. In addition, the complexity of the matters of minds, the low explicitness of theory, the complexity of selection criteria for hypotheses, a lack of representation of thinking process, etc., make it difficult for novices to learn the knowledge required for medical services (Figure 2).

Education Methods Being Practiced

| Conference |
| Reflective journal |
| Narrative method |
| ⋮ |
| Case-method |

Purposes of Development

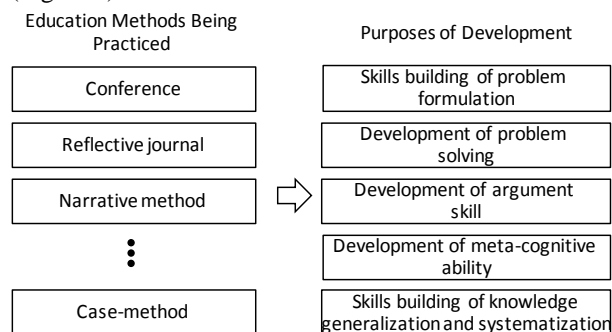| Skills building of problem formulation |
| Development of problem solving |
| Development of argument skill |
| Development of meta-cognitive ability |
| Skills building of knowledge generalization and systematization |

Figure 2.   Fostering tacit knowledge/skills by coaching-thinking process

In this research, we focus on the case-method as an approach to Medical Service Education. One of the educational principles behind the case-method in business management education is "if you want to teach how to deal with a new problem that you have not yet experienced, we should teach them how to think. In fact, the ability of thinking about thinking and the ability of dealing with new

problems can be regarded as different issues in principle but they are completely the same issue in practice." [2].

III.   OVERVIEW OF CASE-METHOD

In the case-method, in order to acquire "skills to deal with new problems that have not been experienced yet", the learners are assigned the task to think how to deal with the "real" problems that have occurred in their own practices and write their thoughts and behavior to cope with the problems as "cases". Then, they join a group discussion on the case with other learners to investigate the validity of their own thinking process from various viewpoints and co-create new solutions to the "real" problem. Through these learning experiences, they learn the learning ability to deal with highly-non-deterministic and highly-complex practical problems [2].

The actual flows of the case-method in business management education are as follows: (1) the instructor distributes the prepared case materials to the learners in advance. (2) The learners organize the contents of the case to analyze and identify the core issues. The analysis should be made based on the facts in the case, the assertion inferred from the facts, insight into the thinking processes of the agents in the case, and the learners' own knowledge. (3) According to the analysis, they think out their own solutions to the problem. After that, (4) the learners join the discussion on the validity of each learner's solution, where the instructor will not join the discussion actively but just raise the topic to be discussed and lead the flow of the discussion [3].

When designing learning materials for the case-method, it is necessary to (1) write down the events that actually occurred, (2) to consider how the learners think about the case and how they will discuss it. Therefore, it is essential for a case-writer to be able to estimate how learners think or how their discussion goes on from the deep understanding of written issues on the case [4].

A.   Learning in Case-Method

In the survey paper on the argument study, Maruno and Tomita [5] claim that most researchers focus on the argumentative skills to examine the rationality or validity of information or knowledge used in the discussion. On the other hand, the skills to produce or externalize ideas in the discussion have not been studied in the research field. However, based on the empirical and the theoretical research so far, the former skills cannot be acquired without the latter ability. It implies that by participating in activities in which the latter skills in required repeatedly, the former skills can be acquired.

Moreover, they support the Kuhn(1991) model of internal thinking process as a dynamic internal dialogue base on Billig's idea that "people engaged in problem solving or decision making, try to make the best judgment of selecting one from some possible options by justifying each of them from many different viewpoints and comparing the justifications to the options" [6] [7]. The reason why they strongly rely on Kuhn's model is that the model shows clear socio-cultural explanation of how the argument guides the

thinking process, which is, one regards the thinking developing process as a more dynamic and clarifies the tight relationship between individual internal process of thinking and social process of thinking such as exchanging position with others and the individual process.

Standing on this viewpoint, the case-method can be used as a concrete educational approach for learning internal dialogue. On the other hand, it is difficult to learn the dynamic internal dialogue associated with social interaction for the reason (shown in Figure 1) that particularly higher cognitive ability is required. In our research project, in parallel, we have been developing an educational program that can reduce the learner's load in learning the association between internal dialogue [8] and social interaction [9].

B. Learning by Designing Case Learning Materials

Ito proposed, by analyzing of effect of the verbalization as a learning strategy, a model of learning goals achievement by verbalization as an integrated model of three learning mechanisms, that is, tutoring that focuses on the learning effect of the teaching activities, self-explanatory quality (nature?) of learning activities, and collaborative learning among learners [10].

We believe that learners can be active entities who can find a meaningful entity for the goal of knowledge acquisition by themselves, and they can achieve the goal by externalizing their self-explanatory of their thinking process to other learners. The externalization processes consist of the two phases of the knowledge description phase, and knowledge building phase and the cognitive conflict can be bridging activities of the two phases as shown in Figure 3. We will discuss the three phases in detail below.

The description phase is an iteration of the internal learning activities to achieve the goal of verbalization by externalizing one's thought in his own experiences. The cognitive conflict is a trigger cognitive process for learners to go into the knowledge building phase by facing the conflict states (realization of cognitive gap among learners' mental models, cognitive differences with other learners, or errors in their knowledge) through the verbalization of their thought and interaction with others. And then, in the knowledge building phase, the learners aim at achieving the goal of resolving those conflict states. The goal of verbalization in the knowledge building phase is to resolve the conflicts and is essentially different from the goal of verbalization in the knowledge description phase. This goal achievement model can be regarded as a learning model that includes the model of thought for dynamic internal dialogue mentioned above.

As mentioned at the beginning of this chapter, the design of case materials requires: (1) writing the case, (2) preparing the content that should be considered and the set of branch points for discussions. In this research, we aim at developing learners' meta-cognitive skills by imposing the design tasks of case-method learning materials on the learners and promoting cognitive interaction with others.
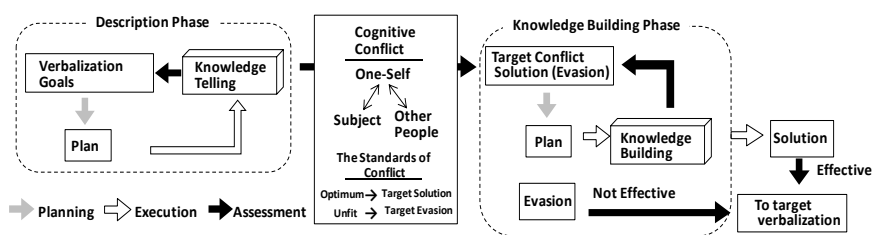

Figure 3. A goal-attainment model of verbalization as a learning strategy

In particular, as an educational program for the medical professions (the nurses in this paper), we developed a learning environment for realizing a model of learning goals achievement by verbalization. Using the environment, the nurses write down (the description) their own thinking process in their experience as cases, guess others' different thoughts, find a cognitive conflict from the thoughts and try to resolve the conflicts by building new knowledge [11] [12].

IV. ENVIRONMENT SUPPORTING LEARNING IN DESIGN LEARNING MATERIALS

In Figure 3, in the learning strategy, learners engage with verbalization activities in the description phase and the knowledge building phase, and the activities are externally observable at the behavioral level. Meanwhile, the activities of making goals, plans, cognitive conflicts, resolving conflicts etc., are not externally observable internal cognitive activities.

Since those activities are relatively abstract and ambiguous, it is difficult for the learners to achieve the learning goals. The difficulties of learning shown in Figure 1 can also be considered as a reason for this ambiguity and abstraction. Our idea of a learning model to reduce the cognitive load for learners to achieve the learning goal is to provide an easy-to-use environment to support learners to reflect their thinking process in their medical services practices. The ontology for patient psychology, medical services, thinking activities and learning activities are incorporated in the environment. And a user-friendly interface for writing case learning materials is provided.
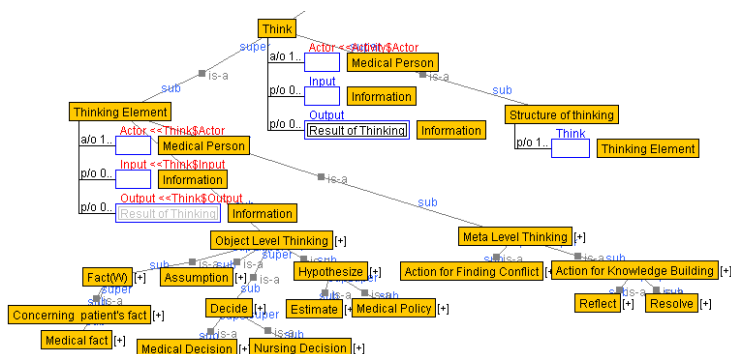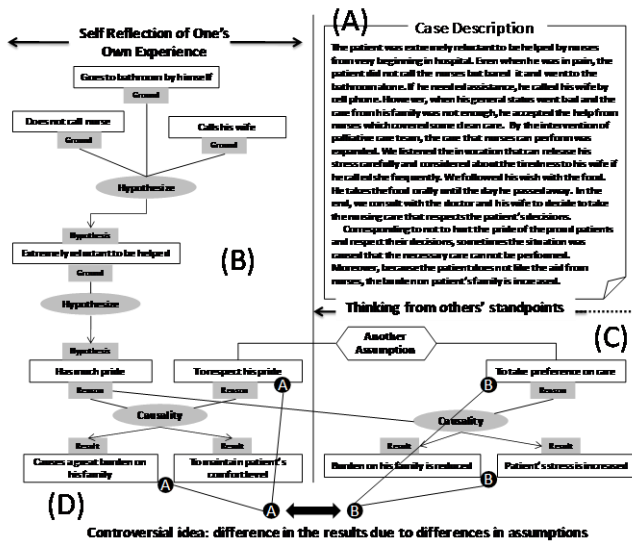

Figure 4. Thinking skill ontology (partial)

Figure 5. An example of thinking representation in case learning material designing

V. THINKING REPRESENTATION IN CASE DESIGN

Figure 4 shows an overview of a part of the ontology for the thinking process in medical services [8]. Using the concepts in the ontology, the learners externalize the reflection of their thinking process in their experiences in the graphic representation as shown in Figure 4.

Figure 5(A) shows the reflection description of thinking in one's own experience and Figure 5(B) shows its graphic representation. The square nodes represent the assertions and the elliptic nodes represent thinking activities such as "hypothesizing", "finding cause and effect" and so on. Figure 5(C) shows the estimated thinking process of another nurse with a different stance from the learner. Figure 5(D) shows the intended issues (cognitive conflict) to be discussed in the case materials, where a nurse wanted to provide more care, but the patient resisted out of pride, even though this added to the burden of the family in caring for the patient. Meanwhile, she guesses that there may be a nurse who thinks, on the assumption of "care priority", that she should provide more care to the patients even though it may cause strong stress on the patient's mind. Then the learner investigated the advantages and disadvantages of the results of different assumptions.

Associating with the discussion in the previous chapter, (B) the visualization of one's own self-reflection can correspond to the description phase. And (C) according to the assumptions at different standpoints, (D) the discussion set up can correspond to the evocation of knowledge building by cognitive conflicts.

VI. LEARNING ENVIRONMENT FOR THINKING PROCESS TRAINING IN MEDICAL SERVICE EDUCATION

Boud (1985) claims reflection is needed at various points: at the start in anticipation of the experience, during the experience as a way of dealing with the vast array of inputs and coping with the feelings that are generated, and following the experience during the phase of writing and consolidation [13].

Combining the learning strategies based on the goal-attainment model of verbalization (Chapter 3) and the thinking representation in case design (Chapter 4), we developed a learning environment that can conduct the externalization of thinking processes using a model of thinking process for self-dialogue consists of three phases, where the learners are required to be able to conduct high quality thinking for self-dialogue which, to describe high quality reflection on ones' own thinking, to find meaningful conflicts, and to create high quality knowledge in order to overcome the conflicts, by continuously developing their ability using tags.

For the different purposes, we have designed two separate thinking representations for the learning environment. One is the text representation. In medical practice, medical professions are used to writing documents with a similar form of representation, such as the electronic medical records. The other is the graphical representation that provides a learner with an easy-to-reflect overview of the logical structure of the thinking process.

We have developed two thinking support tools, Sizhi and Wuzhi, which correspond to the two representation forms. Moreover, in order to integrate these two forms of representation, we have been developing a bidirectional transformation mechanism between these two representations.
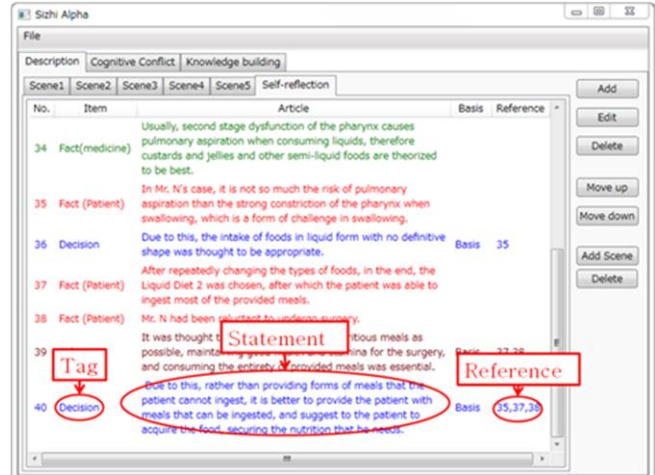

Figure 6. Description phase in Sizhi

Figure 6 shows an example of a case written by a nurse with Sizhi. As shown in the figure, there are three tabs that correspond to the description phase, the cognitive conflict and the knowledge building phase in learning strategies. Each line consists of a statement ID (number), a Sizhi tag, and statement, and may have an additional tag and ID that refer to the logical foundation of the statement in the line. The tags play an important role in encouraging learners to be aware of the logical structure of their own thinking process.
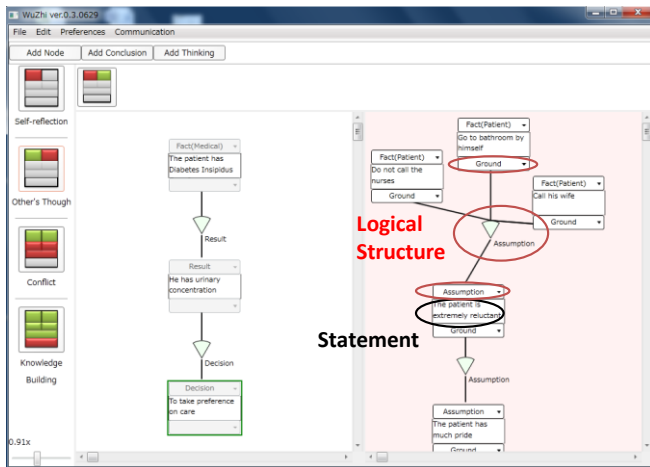
Figure 7.   Description phase in Wuzhi

For Sizhi, we will use the thinking ontology mentioned in the above section to clarify the constituents of thoughts, and the learner is required to express the thinking processes using a set of tags as a framework to express the structure of thinking. The set of tags is designed for nurses to reflect on their thinking process for self-dialogue and consists of nine tags: fact (patient), fact (medical), policy/principle, assumption, decision, medical decision, conflicts, reflect and resolve. The nurses' learning task in the case writing is to reflect on their own thinking process in nursing patients and clarify the structure of the thinking process using the tags.

The most important aspect in designing Sizhi is for learners to clearly write their own cases by reflecting on their thinking process using Sizhi tags, and reflect on the thinking process to find meaningful conflicts. To promote learners to gain deep insight into conflicts, for instance, Sizhi encourages learners to find conflicts between the statements with the policy/principle tag, because the policy/principle tag implies the statement is one of logical foundation of the thinking process.

Wuzhi is a learning representation supporting tool that has the same functionalities for supporting the internal dialogue as Sizhi. But the difference between them is that Wuzhi uses a graphical representation at the description phase. For the reason expressed above, the graphical representation can enhance the effect of the descriptions for clarifying their logical structures. Figure 7 shows a medical case written with Wuzhi. Each node in Wuzhi contains the same form of information (tag, statement and reference) as the line in Sizhi.

In summary, for visualizing the invisible, shapeless, complex structure of thinking processes to support knowledge creation, Sizhi provides learners with tags which clarify various thinking processes, and a tab which encourages awareness of the thinking phases, and is designed with the intent to encourage externalization and careful investigation of ideas that follow those processes. Moreover, Wuzhi gives a clear view of representation for description writing and revising. With the help of a thinking ontology, the representation transformation can be conducted smoothly and firmly.

VII.   PRELIMIANRY TRIAL USE OF SIZHI

A preliminary experiment was conducted with the help of medical specialists including medial advisors, nurses, medical examination managers, researchers and directors from the Faculty of Medicine, Miyazaki University and the Juntendo University Hospital Group.

Because of the time limitation in the preliminary experiment, the participants could not use Wuzhi. So we focus on the evaluation of the effectiveness of Sizhi. In order to investigate the participants' motivation and their self-evaluation, we conducted two questionnaires, before and after using Sizhi. Based on the analysis of the answers to the questionnaires, we have made the following two findings.

A.   Change in Cognition of the Importance of Thinking Skills

We investigated the participants' perception of the importance of thinking skills and the effects it has by self-evaluation. We measured the learners' self-evaluation of how important they think the thinking skills are (perception of importance), and how efficiently they have been using thinking skills before and after the use of Sizhi. To measure the perception of importance, the participants were asked about the target (ex. closely examine whether one's opinions are accurate) which is not related with self-dialogue process, and the distractor (ex. finding flaws in one self), participants were asked to select one from the options: 1- not important at all, 2- not very important, 3- neither, 4- is important, 5- very important. The Figure 8 describes the mean difference in the target column and distractor column before and after using Sizhi. As a result, we found that as the preliminary experiment progressed, the target became higher and the distractor became lower. This result suggests that the understanding of the importance of thinking skills increased by using Sizhi.
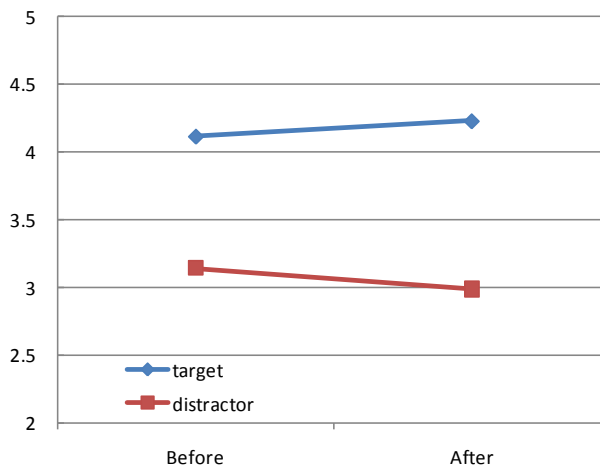

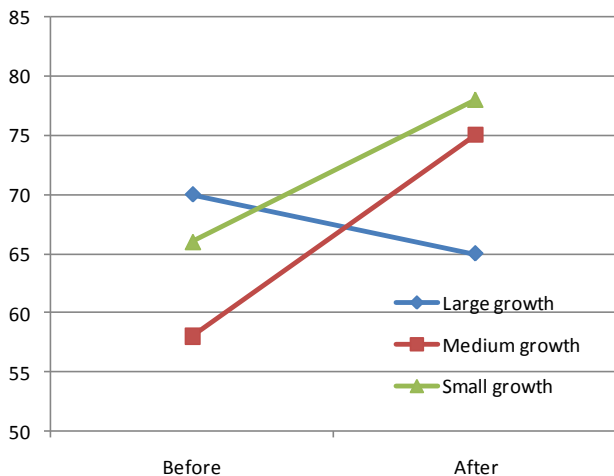Figure 8.   Changes in cognition of the importance of thinking skills before and after using Sizhi

Figure 9.   Changes in self-evaluation for each growing before and after using Sizhi

B.   *The Change in Self Evaluation of Thinking Ability*

We asked the learners for a self-evaluation of their thinking ability. When we checked the differences in the mean after using Sizhi, the self-evaluation improved. Additionally, we split the learners into 3 groups of 5 (large advance, medium advance, low advance) people according to the magnitude of the change in cognition of importance before and after using Sizhi, and analyzed the self-evaluation (Figure 9). As a result, we saw an improvement in self-evaluation in the medium advance group and low advance group, but we could not see any change in the large advance group. The numbers of subjects were too few for this analysis so we could not conclude any statistically significant differences, but the lack of change in self-evaluation in the large advance group suggests that the bigger the advance, reflecting and evaluating oneself becomes more difficult. To support long term thinking skill mastery, it is important to consider how we can help people like this.

VIII.   CONCLUSION

In this paper, we organized a learning model which promotes reflective learning of the case-method for medical service education. As an implementation of the learning model, we have established a learning environment that supports learners to reflect on their thinking process in their experiences by a learning strategy which consists of three case-writing phases: the description phase, the cognitive conflict phase, the knowledge building phase. The final goal of this research is not to make contributions to technological improvement in medical service education but to conduct a proposal of a rational learning model for medical service education. The full educational program we have been developing consists of two parts, that is, one for training thinking skills for internal dialogue and one for training thinking skills for discussion. In this paper, concerning the former part, we have discussed the design rationale of two learning environments, Sizhi and Wuzhi. In our project, as an implementation of the latter part, we have also conducted educational discussion-style workshops at three hospitals. Currently, to shift from face to face discussion to ICT-mediated collaborative learning by integrating, we are developing a learning environment which includes Sizhi and Wuzhi as functional components. In a future paper, we will discuss the design rationale of the learning environment and show evaluation of educational effectiveness through trial use and report on our efforts to put it to practical use in medical service education.

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