

Reflective Thinking Skills Learning Environment for Promoting Knowledge Sharing and Knowledge Co-Construction in 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 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 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, and the knowledge building phase.

【Keywords】 Thinking Skill, Reflection, Case-method, Ontology, Medical Service Education

1. 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 (Yoshikawa, H., 2008). 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 the 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.

2. 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.

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.

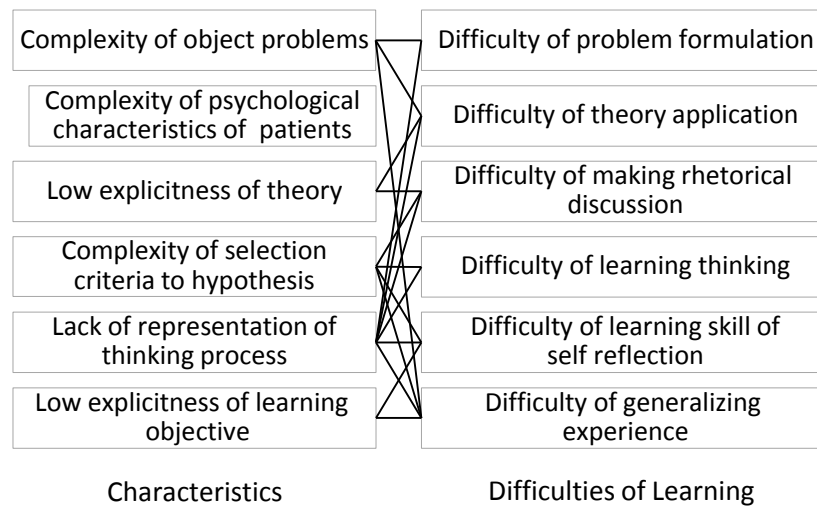


Fig 1: Characteristics of Medical Service and Difficulties of Practical Knowledge Acquisition in Medical Service Education

For the purpose of developing medical human resources with higher cognitive ability as shown in Fig 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 (Fig 2).

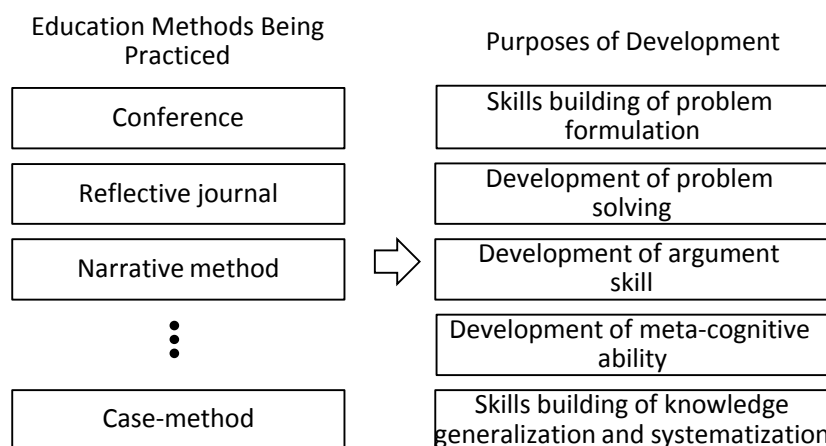


Fig 2: Fostering Tacit Knowledge/Skills by Coaching Thinking Process

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.” (McNair, Malcolm P., ed., 1954).

3. 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 (McNair, Malcolm P., ed., 1954).

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 (Hyakkai, S., 2009).

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 (Ishida, H. et al., 2007).

3.1 Learning in Case-Method

In the survey paper on the argument study, Maruno and Tomita claim that most researchers focus on the argumentative skills to examine the rationality or validity of information or knowledge used in the discussion (Tomida, E., and Maruno, J., 2004). 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’s 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” (Billig, M., 1987) (Kuhn, D., 1991). 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 Fig. 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 (Cui, L. et al., 2011) and social interaction (Morita, Y. et al., 2011).

3.2 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 (Ito, T., 2009).

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 Fig 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 or her 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.

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 (Argyris, C. and Schön, D., 1974) (Boud, D. and Walker, D., 1991).

4. Environment Supporting Learning in Design Learning Materials

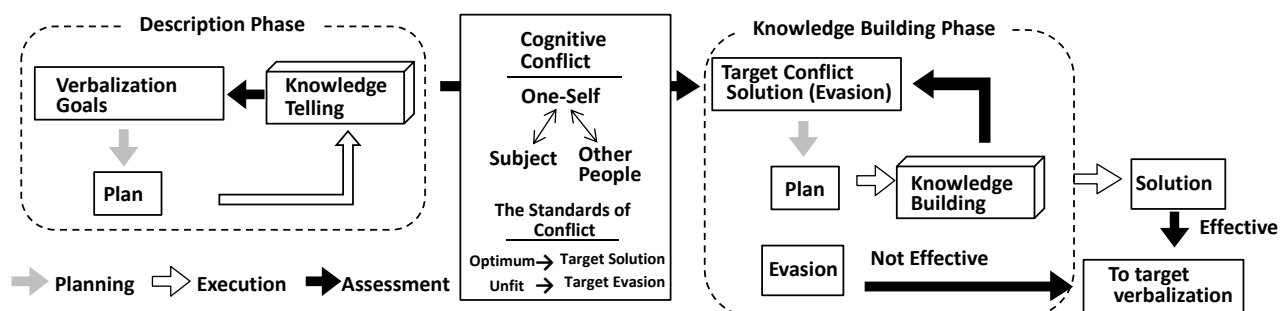


Fig 3: A goal-attainment model of verbalization as a learning strategy

In Fig 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 Fig 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.

5. Environment Supporting Learning in Design Learning Materials

Fig 4 shows an overview of a part of the ontology for the thinking process in medical services (Cui, L. et al., 2011). 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 Fig 4.

Fig 5(A) shows the reflection description of thinking in one's own experience and Fig 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. Fig 5(C) shows the estimated thinking process of another nurse with a different stance from the learner. Fig 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.

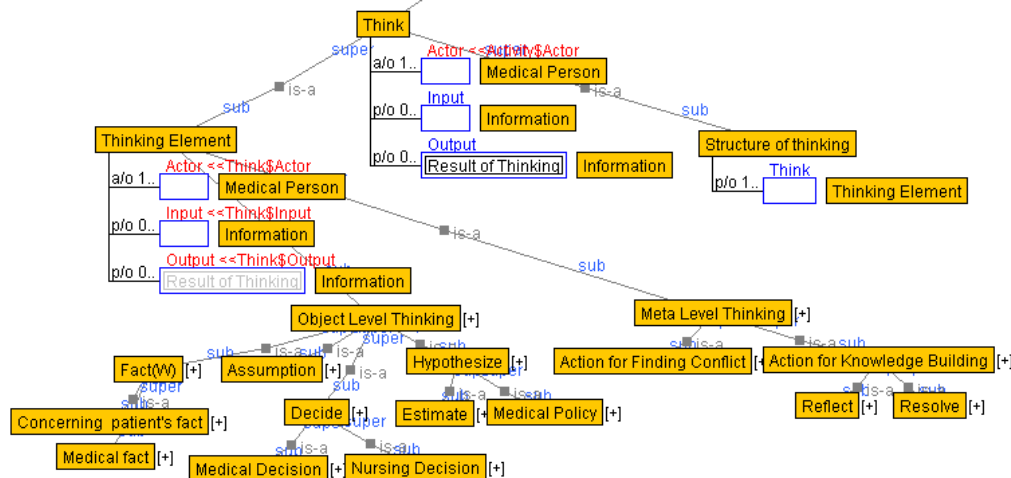


Fig 4: Thinking skill ontology (partial)

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.

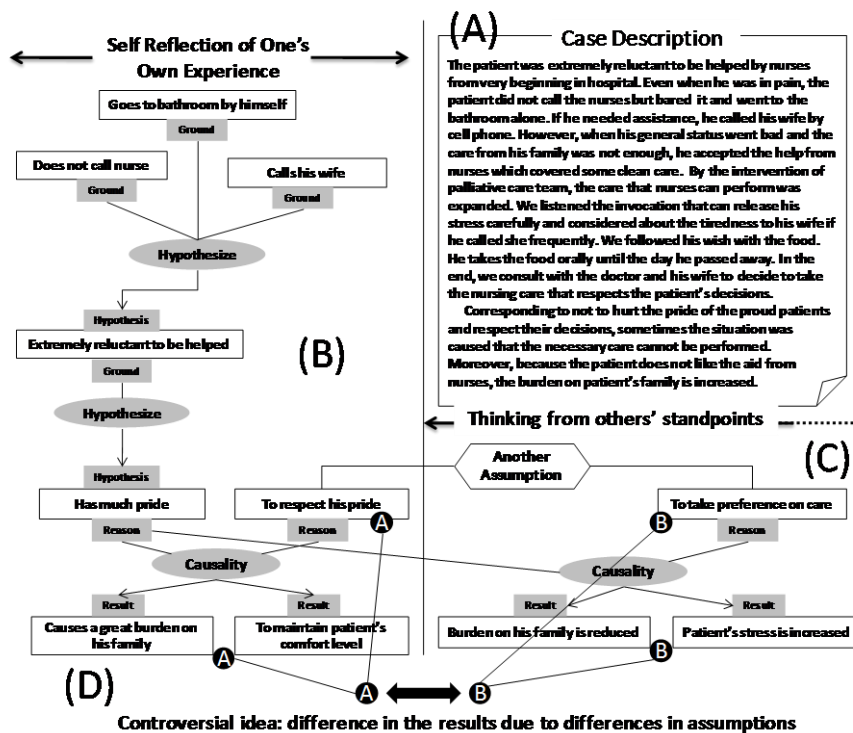


Fig 5: An example of thinking representation in case learning material designing

Moreover, we designed two formations of representation for supporting the externalization of thinking process. One is text representation and the other is graphical representation. Because the learners in the medical service practice always need to write the documents based on the text representation, it is a relatively easy way for them to write down the case. But the demerit of text representation is that it is very difficult for the learner who is not good at expressing his/her ideas logically in text to realize the implicit dependency relationship in logical structure. On the contrary, the graphical representation can help the learner reducing the difficulty of understanding the dependency relationship in logical structure by providing a way to expression it explicitly in graphs. However, if we only use the graphical representation, the ability of externalization in text cannot be fostered. And it is still

very difficult to express his/her idea logically by graphs for the learner who is unfamiliar with the structured logical expression.

In order to make best use of the merits of two formations of representation and solve the problems caused by their demerits for helping learners to attain the learning goals, we designed a learning strategy that includes three parts of processes: A. the learners write down the case in the text representation at first; B. and they can review the case in the same content but represented by the graphical representation, so the awareness to the ill-defined or ignored dependency relationship in logical structure can be raised; C. finally the learners can reflect on the logical expression of thinking process through reviewing the case in the text representation.

6. 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 (Boud, D., 1985).

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.

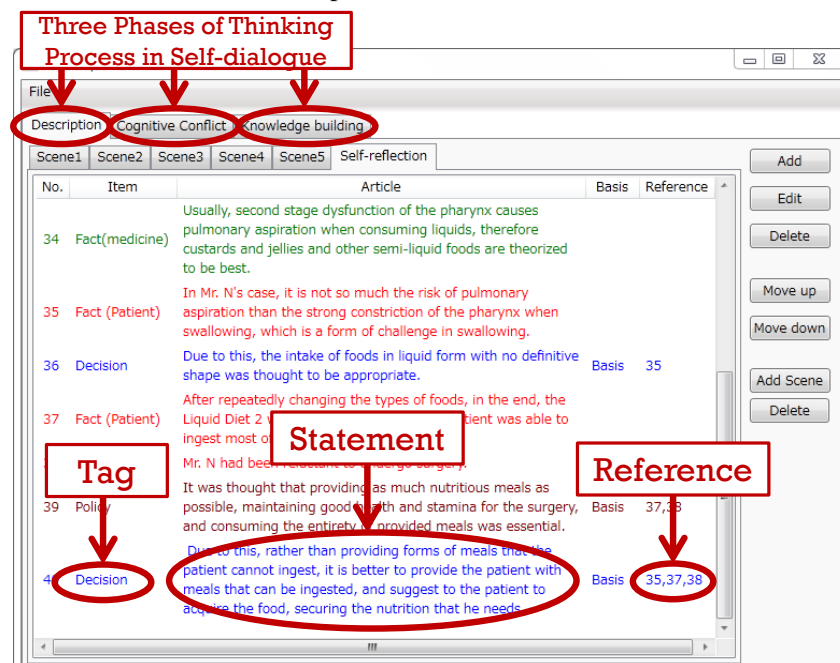


Fig 6: Description phase in Sizhi

Fig 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.

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.

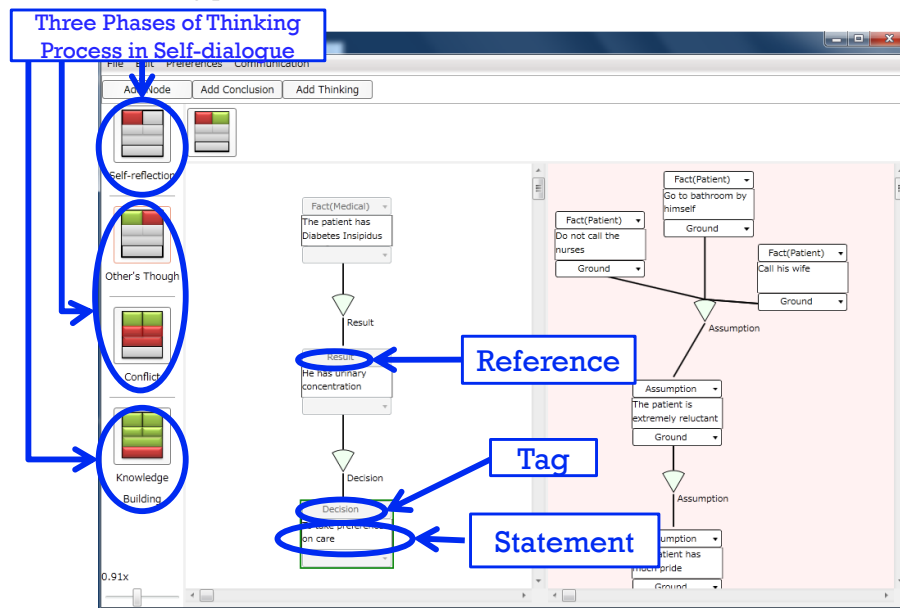


Fig 7: Description phase in Wuzhi

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. Fig 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.

7. Trial Use Experiment of Sizhi and Wuzhi

Because Wuzhi and the thinking representation transformation supporting tools are still in the trial stage, and the medical professions in practice are extremely busy, we conducted a trial use experiment in JAIST.

The goal of experiment is to observe whether the thinking representation transformation can help the learner to notice the shortage of the logical structure in their expression. And the subjects of experiment are 5 graduate students (4 master program first year students and 1 master program second year student) from JAIST.

These five trial users were asked to read the chapter of "Seki Takakazu" and the afterword in the book named "Glory and Failure of Genius: An Introduction to the World's Most Elegant Mathematics" written by Masahiko Fujiwara. And the user is requested to prepare a 10 minutes presentation on these reading materials. During the preparation, the user needs to prepare two different plans of presentation and write down their thinking processes of each plan in the phase of 'Self-reflection' and 'Other's Thought' by using Sizhi. And the automatic representation transformation tool would transform the cases written in Sizhi (text representation) to the cases represented in Wuzhi (graphic representation). The user uses Wuzhi to revise the case.

In the following passage, we will show an example of the case revision result that indicated how the user

reviews the case by comparing the case before revising and after revising in Wuzhi.

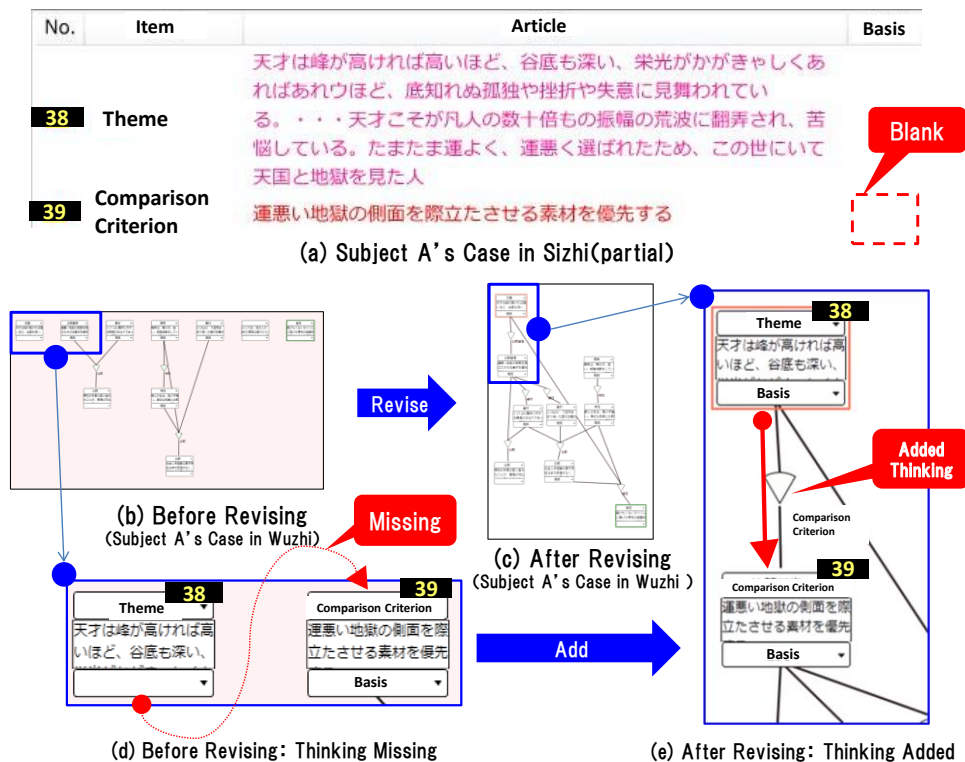


Fig 8: User A's Case Revision by using Wuzhi: Addition of Missing Thinking

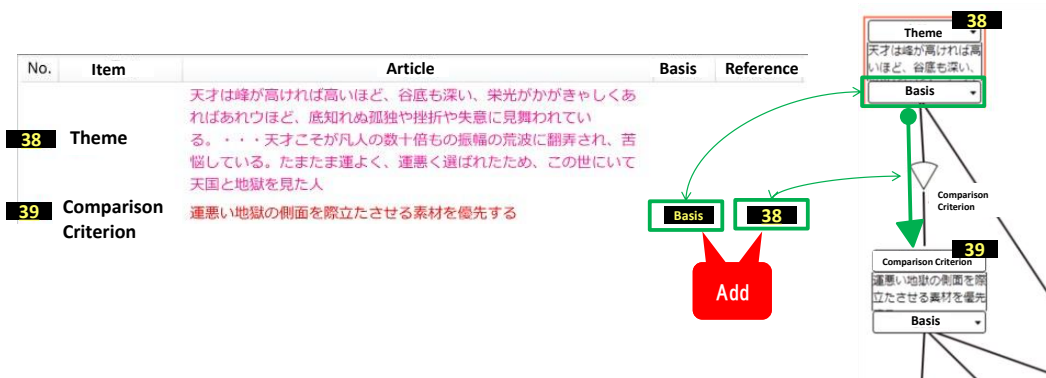


Fig 9: Changes in Sizhi Case Responding to Revision Result in Wuzhi

The Fig 8 shows how the User A revised the case by using Wuzhi. The description in Fig 8 (a) is a part of the User A's case description in Sizhi. The number in black textbox means the number of a description statement (e.g. 38 means statement number 38). And in following passage, the statement 39 is called St.39 for short.

In this case, we focus on St.39 because its field of basis was blank. The tag of St.39, "Comparison Criterion" means the criterion of selection when selecting a solution from many prospective ones. According to the content of St.39, we can estimate that User A wanted to express that St.39 plays a role of a criterion when selecting the materials for presentation. But it is not necessary that the statement with the tag "Comparison Criterion" must have a basis.

The Fig 8 (b) shows User A's case in Wuzhi before revising and the Fig 8 (c) shows the case after revising. From the overview of the case before and after revising, we can discover that there are many places have been revised like addition of links between some nodes. So the structure of User A's thinking process representation has been changed significantly. Here, it is necessary to notice that we cannot determine these changes in this case mean the changing of the user's idea or not. It is possible that User A has changed the idea or he/she just change the expression.

The Fig (d), (e) is the enlargements of (b), (c) that indicate the change of St.38 and St.39 in (a). This change is

about adding a link between the statement of "Theme" and the statement of "Comparison Criterion". The Fig (d) indicates an expression that User A wrote down the "Comparison Criterion" statement without any basis. And Fig (e) shows an expression that User A wrote down the "Comparison Criterion" statement based on the "Theme" of the author. In other words, the role of St.39 was changed from an assumption to an inference. From the content of St.38 and St.39, we can presume that there is a logical dependence between St.38 and St.39. So we can conclude this change is valid. But we also need to notice that we cannot determine this change is a change of idea itself or a change of the expression to the idea from the data we have.

The Fig 9 shows how the result of the revision in Wuzhi reflects on the case written in Sizhi. It indicates that St.38 was added to be a basis of St.39 by using the field of reference.

Although the data of the five users from the first time trial use cannot prove the effectiveness of the thinking representation transformation strategy, we have observed some signs from the case revisions which can infer that the thinking representation transformation strategy can promote noticing the shortage of the logical structure in their expression. In other words, the shortage of logical structure in the case written by Sizhi might be noticed when reviewing the case represented in Wuzhi. In order to clarify the effectiveness of the learning strategy and the learning environment, we need to collect more data from experiment.

8. 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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