A Design Intention Representation Method of Education Program for Fostering Meta-thinking Skills

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【Abstract】The design intentions of the education for fostering the skills to solve the authentic, contextual and social problems are sometimes implicit and difficult to represent appropriately. It is caused by the variety of the factors implicated in the learning design and the complexity of the relationship among those factors. In this paper, we developed an ontology-based representation framework for clarifying and representing the design intentions for supporting the knowledge co-creation and sharing among the learning designers towards the education of meta-thinking for solving the problems which do not always have a clearly correct or universal answer in nursing service.

【Keywords】Nursing Service Education, Education Design Supporting, Meta-thinking Skills

1. Introduction

For the purpose of linking the learning theories and educational practices to improve instruction through the analysis of learning needs and systematic development of learning materials, the research field of instructional design has been developed for nearly 70 years and many theoretical frameworks, for instance, ADDIE Model (Gagné et al., 2004), Gagné's Theory of Instruction (Gagné, 1985), and ARCS Model (Keller, 2009) have been proposed.

Along with social progress towards the age of Knowledge Society, the educational philosophy is shifting to one which emphasizes on lifelong and self-directed learning for acquiring the competences such as higher-order thinking skills, which are essential in the societal context (Reigeluth, 2009). To keep up with the changes in the present age, it is necessary for us to rethink the design of learning activities and content, and even the method of design. Within this context, the concept of "Learning Design" is introduced as an approach of making design processes more explicit and sharable to enable teachers to develop more effective learning environments and interventions for learners and help make the intended design more explicit and hence sharable with other teachers and learners (Conole, 2012).

Agostinho (2009) categorized the commonly used learning design languages into four main types: pedagogical patterns, generic learning designs, contextualized learning design instantiations, and executable runnable versions. In order to support the representation of learning design as a result and to provide a mechanism for interpreting and discussing the designs as a process, the various types of learning design languages have been created. Because the learning design is a messy, creative and iterative process, and practitioners think about design at a number of levels and oscillate between the different factors involved in their decision making (Conole, 2012), it is a challenge to clarify and represent the design intention behind the outcomes of design process.

In addition, towards the spread of social constructivism view of learning and education, because the focus of learning is transferring from knowing facts and procedures to acquiring the knowledge and skills to solve the authentic, contextual and social problems which do not always have a clearly correct or universal answer. The characteristics of those problems are that i) the problem can be formulated or defined from various perspectives; ii) the solution to the problem is not unique and the criteria for choosing a better solution are implicit or situation-dependent. For acquiring the knowledge and skills to solve those problems, some learning strategies, such as Project-based Learning (Krajcik & Blumenfeld, 2006), Discovery Learning (Ito, 2005), Case-based Learning (Williams, 1992) and Dialogic Learning (Renshaw, 2004) have been proposed. Those strategies are all based on the belief of “scaffolding the learning rather than teaching”, which means that because learning is regarded as triggering by the interaction with environment such as communication with other people or involve in the social activities, the way we could help learner to
develop him/herself is to provide a learning environment. Because the implementation and refinement of “scaffolding” style education still depend heavily on the specialized and empirical knowledge of the learning design practitioners, it is a crucial issue to establish a methodology of learning design for acquiring the knowledge and skills to solve the authentic, contextual and social problems in order to satisfy the needs and expectations of today’s learner.

In this research, by using a constructive approach of creating a framework that consists of various correlated levels of design representation, we aim to clarify the necessary requirements in learning design intention representation for supporting the knowledge co-creation and sharing among the learning designers towards the education of meta-thinking for solving the problems which do not always have a clearly correct or universal answer in nursing service.

2. Education Program for Promoting Meta-thinking Skills

2.1 What are Meta-thinking Skills?

In this research, we focus on the education for fostering the meta-thinking skills of nurses. In medical service, nurses always have a conflicting standpoint between doctors and patients because of the responsibility of their profession. This standpoint provides nurses a neutral viewpoint to review medical service for both considering about the rationality from medicine as a science and respecting the needs from patients because of humanity. However, it is difficult to balance them proficiently, because it requires some high level capabilities, such as understanding the patients’ frame of mind and concept of values from observation, conducting medical acts in consideration of those minds and values, communicating with doctors for conveying patients’ needs in a convincing way, and etc. Moreover, the conflicts caused by or within the different positions are actually common in the medical practice. Within this context, although reflection (or reflective thinking) is deep ingrained in the education of nursing procession, it is extremely difficult for nurses to reflect their own thinking concurrently with deducing the other’s thought to understand the essence of conflict from a higher-level position, and furthermore to utilize the experience of conflicts and confrontations to enhance their capabilities.

For the purpose of clarifying the objectives of education, the actions (ACT) related to the thinking capability we aim to educate are summarized as follows:

ACT1. Thinking on problems solving;
ACT2. Reflecting on one’s own thinking;
ACT3. Deducing other’s thought;
ACT4. Understanding and integrating conflict between one’s own thinking and other’s thought;

In fact, the actions described above occur simultaneously in nurses’ daily work. The relationships among these actions are shown in Fig 1. ACT1 is the action of thinking on problem solving while facing the problem. When ACT1 is ongoing, ACT2 and ACT3 also emerge in mind on the analysis of the situation occurs in the problem. Based on the thinking result of ACT2 and ACT3, “ACT4: Understanding and integrating conflict between one’s own thinking and other’s thought” is conducted. The processes of ACT2 and ACT3 are defined as base-level and the process of ACT4 is define as meta-level, because all of ACT2, ACT3 and ACT4 are the actions of thinking and the thinking of ACT4 is engaged by regarding the thinking of ACT2 and ACT3 as targets. In this research, we use the terminology “meta-thinking” to refer to the concept more detailed than metacognition which is a rather broad and complex concept which consists of many components (Sannomiya, 2008; Tarricone, 2011). In other words, meta-thinking is defined as the thinking that can monitor the one’s own cognitive status of on understanding and integrating conflict between one’s own thinking and other’s thought (ACT4), and can control the one’s own thinking for a positive direction to enhance the performance of the action (ACT4). In the next section, the author will introduce the education program for fostering these meta-thinking skills.

2.2 Knowledge Building Method (KBM) Workshop in Nursing Service Education

For the purpose of fostering the meta-thinking skills of nurses, we design an education program named Knowledge Building Method (KBM) Workshop (Cui et al. 2011). The workshop had been conducted in several collaborative medical institutions (left of Fig 2). The fundamental design of KBM Workshop is presented in Fig 2 (right of Fig 2). The education program consists of five fundamental parts: lecture on
case-writing, case-writing practice, case reviewing, discussion stage, and lecture on meta-thinking skills and isomorphism basis. Although this fundamental design appears insignificant, we have designed an elaborate structure for this education program in which there are numerous structuring learning goals for the purpose of supporting the learners to achieve the educational objectives.

![Diagram of learning phases]

For the purpose of facilitating the learning of thinking skills, especially for promoting the reflection on the process of thinking which is always quite difficult for the novice to be conscious of, we have developed a reflective case-writing supporting tool named “Sizizi”. The tool is designed to support the learner verbalizing the result of thinking in an easy-to-reflect representation by the functions of the case-writing phases, the reference representation and the tag representation (Chen et al, 2011).

The tool consists of three case-writing phases: Knowledge Description Phase, Cognitive Conflict Phase and Knowledge Building Phase. In Knowledge Description Phase, the learners write down what had happened on practical cases in the sub-phase named “Scene” and reflect on what themselves had thought on the cases and represent those thinking in the sub-phase named “Self-reflection” (left of Fig 3). In Cognitive Conflict Phase, the learners reflect the cases from a completely different perspective and represent those different thought in the sub-phase named “Other’s thought”. And they compare and analyze these two perspectives to understand the essence of conflicting and express the result in the sub-phase named “Conflict” (right of Fig 3). Based on the reflections in former two phases, the learners continue to consider the ideas how to solve the conflicting, what the lesson had been learned from the case and what shall be considered if the similar cases happened. They represent those ideas in Knowledge Building Phase.

In the tool, the basic function for supporting the thinking verbalization is called “Line” (A of Fig 3) which includes “Statement”, “Tag”, “No. of line”, and “Reference”. “Statement” is the content of thinking.
In order to help the learner to reflect and represent the thinking logically, the functions of reference and tag representation are created. The logical structure of thinking is represented by the “No. of line” and “Reference” (B of Fig 3). And “Tag” (C of Fig 3) is designed as an indicator for learners to clarify and represent what role a component of thinking plays in the logical structure. For example, as shown in left of Fig 3, a statement “only until the safety of baby is secured, the mother would be allowed to hug the baby” is labelled with a tag “Decision” and references with Line No. 5 and No. 6. It means the nurse made the decision based on “Guess” of “The mother felt guilty that she could do nothing for her baby. And she wanted to hug her baby” and “Policy” of “While understanding the feeling of the family, the safety and treatment of the patient were given first priority”.

In fact, Fig 3 shows a part of the practical case written by using the tool. In the sub-phase “Scene”, the nurse (the author of case) described an actual story of her hard decision on the conflicting of allowing the mother to hug the new-born baby who is in danger, or refusing the mother’s request in consideration of the baby’s safety. Because the nurse in the case had refused the mother and the baby passed away in final, the nurse felt very distressed for considering that it will be better if allowing the mother to hug the baby. Therefore, the memory on “Thinking on Problem Solving” (ACT1 in Fig 1) is evoked and verbalized in “Scene”.

In the sub-phases “Self-reflection” and “Other’s thought”, by using “Tag” and “Logical structure” of the tool, the nurse clarified her thought when she made the decision and considered about the optional decision of “allow the mother to hug her baby”. The thinking of “Reflecting on One’s Own Thinking” (ACT2 in Fig 1) and “Deducing Other’s Thought” (ACT3 in Fig 1) is triggered.

In the sub-phase “Conflict”, she clarified and represented two hidden believes (tagged “Policy”) behind the conflicting which are “while understanding the feeling of the family, the safety and treatment of patient were given first priority” (D of Fig 3) and “respect the mother’s hope while closely monitoring and minimizing life-threatening factors” (E of Fig 3). After considering about other optional decision, the nurse realized that both of decisions can possibly lead to the bad result and felt released from the regret. The thinking of “Understanding and integrating conflict between one’s own thinking and other’s thought” (ACT4 in Fig 1) is elicited.

In summary, by using the reflective case-writing supporting tool, the novice learners are expected to be able to verbalize and clarify the results of thinking. Moreover, it is also helpful to raise the learner’ attentions on the process of thinking through reviewing the results of thinking (Chen et al, 2012). In the next chapter, the designed educational scaffolding for fostering the meta-thinking skills named “Isomorphism”, the activities that support the learners to understand the scaffolding, and the design intentions of those activities will be described.

3. Learning Design Intentions behind Education Program

Based on the brief introduction on the meaning of meta-thinking skills and the education program for fostering those skills in chapter two, the intentions of the conducted activities in the education program will be elaborated on in this chapter.

3.1 Learning Design Intention behind Relationship between Case-writing and Discussion

In the case-writing, the learners verbalize their thinking into cases by using the reflective case-writing supporting tool, which provides them a perspective to reflect the thinking in consideration of logical relationships of each constituent. But it is difficult for learners to direct their own thinking consciously to a positive direction, because normally they are focusing on generating the content when writing cases. In contrast, in discussion, the learners can ask other people questions or receive the questions from other people. These questions may trigger a better discussion point or a dissenting view which is useful for deepening the discussion. In fact, it is difficult for the learners in discussion to be aware of the situation of discussion from a higher perspective, because they are focusing on expressing their own viewpoints or understanding others’ viewpoints. In order to utilize the experience of learning in case-writing and learning in discussion for fostering the meta-thinking skill, the educational scaffolding named “isomorphism” is designed.

The concept of “isomorphism” is originated from mathematics. It is described as “a correspondence (relation) between objects or systems of objects expressing the equality of their structures in some sense” (Hazewinkel, 2001). In this research, isomorphism is defined as regarding thinking by oneself in case-writing and thinking as a group in discussion as the same structure”. This “scaffolding” helps the learners to construct a mental model on fostering meta-thinking skill by utilizing social interactions. It means that if the learners understood the “isomorphism of self and group thinking”, assimilating the
directing questions from discussion to use them for directing their own thinking when thinking by themselves and viewing the discussion from a higher perspective exactly as reflecting on the writing. In order to help learners to understand this scaffolding for fostering the meta-thinking skills, the education scene “Case Reviewing” for bridging the experience of the case-writing and discussion is designed.

3.2 Learning Design Intention behind Case Reviewing

Case reviewing is generally regarded as a series of activities (such as correcting the cases written by learners and commenting on the contents of modification) to promote the skills which are directly related to the case-writing, such as the skill of verbalizing one’s own thinking logically or merely considered as a part of education program for improving the quality of case. With regard to KBM Workshop, besides the improvement of thinking verbalization skill mentioned above, two extra skills have been considered as the learning outcome of the case reviewing.

Learning design intention behind case reviewing: Monitoring of Self’s Thinking

The first one is a program dependence skill named “Monitoring of Self’s Thinking” which means the skill of observation and analysis of one’s own thinking condition from a higher level. In the case reviewing, the instructor gives comments on the cases. These given comments are not merely about the correction of the mistakes or inappropriate logical expressions in the case but also include the contents which are intended to raise the self-awareness of the thinking style problems which possibly lead to the mistakes or inappropriateness in the case. Therefore, through receiving these well-designed comments from the instructor, the learners’ awareness on the higher-level reflection to analyze the conditions of their own thinking for discovering the inappropriateness of thinking style can be promoted. Therefore, the learning goal “can realize inappropriateness of one’s own thinking style from reflection on one’s own thinking process” can be achieved. And it is in an effort to acquire the skill of “Monitoring of Self’s Thinking” and plays a role of base for the learning the universal and transformational skills.

Learning design intention behind case reviewing: Control of Self’s Thinking

The second one is the program dependence skill of “Control of Self’s Thinking” which means the skill of direction of one’s own thinking. Besides the comments for raising self-awareness of the thinking style problems, the guiding questions such as “How about creating another decision in an ideal viewpoint and using insight to estimate the possible result” are also provided. The purpose of providing those questions is for giving the learners some examples on how to direct the thinking to a positive direction. The reason why listening to the reviewing on other’s case is an effective learning chance is because when the learners receive comments from the instructor, even though the comments are created under the consideration of learners’ motivation, the learners may still feel nervous. So it is possible to cause the learner to lose sign of the comments which are related to the learning on the skill of “Control of Self’s Thinking”. By contrast, when the learners listen to the reviewing on others’ cases, they can view the comments from a relatively objective perspective, and it is helpful for them to realize the necessity of directing their own thinking by asking themselves those questions. Therefore, the learning goal of “can realize necessity of directing one’s own thinking to prevent thinking inappropriately” can be achieved by the learning strategy “discovery learning from experience of coaching on verbalization when the instructor gives comments on others’ case”. This goal is one of steps for acquiring the skill of “Control of Self’s Thinking”.

In summary, we have used lots of words to express some of the design intentions of the case reviewing activity in KBM Workshop in this chapter, which indicates that the design intentions of education program for fostering meta-thinking skill are extremely implicit and difficult to express verbally. In the next chapter, the representation framework for representing these implicit design intentions will be introduced.

4. Learning Design Intention Representation Framework

The design intentions of education for fostering the higher-order thinking skill, especially meta-thinking skill as we discussed in chapter three are extremely implicit and difficult to express verbally, because the interrelated factors and their relationship behind the designed artifacts (such as textbooks, learning programs, learning supporting tools, even the prompts performed in educational practice) are various and experience-base. In order to reduce the implicitness of design intentions, we create a learning design representation form to represent the variety of interrelated factors and the complexity of the relationship of these factors behind the designed artifact.
4.1 Basic Representation Frame: Learning Unit

An example of the basic element in the representation form is shown in Fig 4. The whole of the box in the figure is called “Learning Unit”. Learning unit is created as a frame for integrating the concepts related to the design of the education program, including Object of Learning, Attainment Level of Learning, Learning Goal, and Learning Strategy. The fourth row of the box represents “learning goal” that is the core concept in learning unit. It states the goal which the learning unit aims to. The content in the first two rows in the box represents the Object of Learning which means what kind of skill, knowledge or attitude is expected to acquire. And the contents in the third row indicate the attainment level of learning on the object of learning. In the scale for representing the attainment level of learning, three levels – cognitive, associative, autonomous are defined as follows. These concepts are borrowed from three stages of skill acquisitions which are summarized by Anderson, J. (2009).

Cognitive level: Knowing fundamental knowledge or knowledge on how to practice skill.

Associative level: Understanding knowledge or skill through learning experience and being able to perform tasks related to knowledge or skill with aid of “scaffolding”.

Autonomous level: Applying knowledge or skill on appropriate situation without “scaffolding”.

The example shown in Fig 4 represents that the learners are expected to achieve the learning goal “can verbalize the result of thinking with a conflict included two policies which can reflect the essence of viewpoints from two conflicted sides” by the learning strategy “coaching on thinking verbalization through case reviewing”. Moreover, this learning goal is not independent but a part of continuous process of the learning which regards the program dependence skill of “Base-level thinking verbalization and thinking” as the object. It implies that this skill is intended to be acquired gradually within the program through several steps. Moreover, acquiring this program dependence skill is not the final goal of learning but a base for acquiring the skills which are universal and transformational.

4.2 Framework for Representing Learning Design Intention: Educational Plan

In order to explain how to represent the design intentions of education program for fostering meta-thinking skill, the educational plan related to the scene of case reviewing for the learners who attend KBM Workshop for the second time is indicated in Fig 5. In the figure, the symbol of box (A~G) means “Learning Unit” and the line between the boxes represents the relationship among the learning units. Furthermore, the horizontal axis in the figure represents the education scenes in chronological order, and the vertical axis represents the means-ends relationship of learning unit.

To be specific, three symbol boxes within the frame with a blue dotted line in Fig 4 indicate three different learning goals which are intended to be attained during the case reviewing.

Representation of learning design intention behind E-D and E-C: Provide a Discovery Learning Environment

The box marked with “E” (abbreviated as “Learning Unit E” in the following passage and other boxes will be abbreviated in the same way) represents the same learning unit indicated in Fig 5. The experience from the process of learning in Learning Unit E also provides a discovery learning environment (represented by the red lines marked with “J” and “K”) for the learning goals described in the boxes marked with “D” and “C”. The meaning of “provide a discovery learning environment” is that the experience from the process of learning within Learning Unit E is also instructive for achieving the implicit and indescribable learning goals which are related to the different skills.

In detail, Learning Unit D represents that the learners are expected to achieve the learning goal “can realize inappropriateness of one’s own thinking style from reflection on one’s own thinking process” by the learning strategy “discovery learning from the experience of coaching on verbalization when the instructor gives comments on reviewing one’s own case”. And Learning Unit C represents that the learning are expected to achieve the learning goal “can realize necessity of directing one’s own thinking to prevent thinking inappropriately” by the learning strategy
“discovery learning from experience of coaching on verbalization when the instructor gives comments on others’ case”. These two learning units actually represent the learning on “two other skills being considered as the learning outcome of case reviewing”, which has been discussed in chapter three.

In addition to these three learning units (C, D and E) that are directly concerned with the learning during the case reviewing, there are also several other relationships among these three learning units and others. In order to explain the complexity of the relationships, a typical example is briefly introduced in the following paragraphs.

**Representation of learning design intention behind B-C and A-G: Provide Knowledge-based Preliminary**

As illustrated in Fig 5, Learning Unit B and C are connected by the green line marked with “I”, which means that the learning experience on the achieved learning goal “can understand the meaning of meta-thinking” from the participation of previous workshop provides a knowledge-based preliminary to the learning described in Learning Unit C. Similarly, Learning Unit F is also promoted by the experience from Learning Unit C.

**Representation of learning design intention behind C-F, C-G and F-G: Experience-base Promotion**

Moreover, the achievement of the learning goal “can realize value of isomorphism for assimilating others’ questions to direct one’s own thinking” described in Learning G is supported by the experience from Learning Unit C, F. One of the major differences between the relationship “Experience-base Promotion” and “Providing a Discovery Learning Environment” is that the former emphasizes the effect of the experience and the latter emphasize the effect which comes from the learning activities occurring simultaneously within the same education scene.

In order to reduce the ambiguity of representation and provide a framework to support the knowledge co-creation on learning design among designers, we have developed an ontology-based representation framework for clarifying and representing the implicit design intentions.

**5. Ontology-based Representation Framework for Clarifying Design Intention**

Theoretically, ontology is defined as “formal, explicit specification of a shared conceptualization”
(Gruber, 1993). It is widely used in knowledge engineering, artificial intelligence and computer science; in applications related to areas such as knowledge management, natural language processing, e-commerce, intelligent information integration, bio-informatics, education (Gómez-Pérez et al., 2004). In ontology, we can define the meaning of terms and the relationship between them in order to provide common vocabularies of an area for a conceptual framework that can be used for representing the knowledge.

In this research, the author uses the Hozo ontology editor (Hozo Ontology Editor) to build the ontology-based representation framework for clarifying the design intention of education program. The most significant feature of Hozo ontology editor is that it provides a function to support users to build ontologies being aware to distinguish role concept from basic concept (Mizoguchi, et al, 2007). This feature is quite practical to explore and represent the essence of the concept which is always easily-confused.

In order to explain how to use the ontology to clarify and structure the concepts related to learning design for representing the design intention, a concrete example is demonstrated in Fig 6 and Fig 7. Fig 6 indicates an example of “Provide an Environment for Discovery Learning” relationship between two learning units. The representation form of “Education Scene” is modified from the style of “horizontal axis” in Fig 5 to style of being a part of Learning Unit (on the button) for representing the relationship between learning units clearly. The learning unit on the left side (same to Learning Unit E in Fig 5) integrates the learning on the skill of “base-level thinking verbalization and thinking” in the scene of “case reviewing” through instructor’s coaching on thinking verbalization. And the learning unit on the right side (same for Learning Unit D in Fig 5) integrates the learning on the skill of “Monitoring of Self’s Thinking” in the scene of “case reviewing” through the discovery learning from the experience of coaching on verbalization when the instructor gives the comments on one’s own case. Because the learning goal of discovery learning is linked to several different skills, the appropriate explicit prompts are necessary for facilitating the learning on the implicit goals or for inhibiting the obstructive factor to learning.

The ontology in Fig 7 is created for representing the learning unit (the learning unit on the right side in Fig 6) which uses the discovery learning as the learning strategy. The A (within the frame in dotted line) in Fig 7 represents the concepts related to the learning goal. The B means a collection of education scene (one scene or a group of scene). The C represents the learning strategy which is used in the learning unit and D means the source learning unit which provides the discovery learning environment. The E represents the education strategy which is necessary to facilitate the learning. Because it is crucial to represent that during what kind of activity the learning by using discovery learning strategy can be triggered, in the ontology-based framework, the concept of “learning activity” is defined as an attitude (c-3 in Fig 7) to the concept learning strategy. Moreover, because the characteristic of the discovery learning is that the target of learning is implicit to the learner, the object of learning in the learning unit which provides the learning environment must differ from the object of learning in the learning unit being provided. In the framework, this characteristic is represented by the “different” relationship (R3 in Fig 7) between the attitude “learning object” (a-2) to the concept learning goal and the attitude “learning object” (d-3) in the concept source learning unit.
6. Conclusion and Future Work

In this paper, the author addresses the necessity of establishing a methodology of learning design for supporting the acquirement of the knowledge and skills to solve the authentic, contextual and social problems in order to satisfy the needs and expectations of today’s learner. As a step to achieve this common goal in the field of learning design, we focus on how to clarify and represent the design intentions for supporting the knowledge co-creation and sharing among the learning designers towards the education of meta-thinking for solving the problems which do not always have a clearly correct or universal answer in nursing service. For the purpose of reducing the implicitness of design intentions which caused by the variety of interrelated factors and the complexity of the relationship of these factors behind the designed artifact, an ontology-based framework is constructed.

In the future, we will develop a learning design intention representation tool that is embedded the ontology-base framework to put the representation method into practical use. And we will also conduct experimental trials in collaboration with the learning designers for evaluating the effectiveness of the framework and tool. Furthermore, we will continue to research on the method of learning assessment, which is essential to enhance the quality of learning in education program.

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