Designing Lessons with an Ontological Modeling Approach in Practice

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Abstract: In this paper, we discuss the effectiveness of an ontological modeling approach in practice. Although a lesson plan is a document that describes the plan of a lesson, the design rationale behind it tends to be implicit. The authors have developed an ontology called OMNIBUS and a theory-aware authoring system called SMARTIES. This paper describes the result of the experimental use of them in the real task of schoolteachers.

Keywords: instructional design, ontological engineering, and authoring system

Introduction

Teachers develop their teaching skill in their practice through self-reflection and discussion with other teachers or experts [1][2]. “Lesson study” is a systematic activity to foster such development in a group setting [5]. Lesson study aims to improve design of a lesson (lesson design) through discussion among teachers before the teacher carries out the lesson and to bring reflection through evaluating the lesson after the lesson. In designing a lesson a teacher makes a document called “lesson plan”. This is the description of a lesson design and a document for sharing it among teachers. If a teacher can make a lesson plan faithfully reflecting the lesson design in his/her mind, teachers can share the design rationale of the lesson. However, as most of the lesson plans describe mainly concrete activities of teachers and learners, the design rationale underlying lesson plans is often unclear.

This study aims to help teachers make high-quality lesson design and reflect it on lesson plans through an ontological engineering approach [6][7]. The task of making lesson plan consists of the following two subtasks: considering the content and expressing it in a format. This study considers that a difficulty in making lesson plans faithfully reflecting lesson design in a teacher's mind is caused by doing the two subtasks at the same time in design process. Therefore, the approach of this study is to separate these two tasks clearly. This study sets an objective to achieve the goal. It is to enable teachers to faithfully describe lesson design in their head without the constraints of lesson plans. This helps them to check the validity of lesson design and improve it and then to reflect the lesson design to a lesson plan sufficiently.

This paper discusses the effectiveness of OMNIBUS ontology and SMARTIES authoring system [3] in practical lesson design activities with the result of practical experiences that the authors have conducted with an official research group of schoolteachers of Tokyo prefecture in Japan, named “ToChuSha”. The group consists of only practicing schoolteachers of all ages that are from novices to experts. The authors conducted thier practical study when they were preparing for presentation of lesson plans and demonstrations of lessons according to them at an annual domestic conference on

educational research of social studies in junior high school in Japan. This paper discusses the results of the practical study from the viewpoint of changes of lesson plans by introducing OMNIBUS and SMARTIES in designing a lesson.

The structure of the rest of this paper is as follows. The next section gives an overview of OMNIBUS and SMARTIES and defines the role of them in this study. The third section explains how to introduce them in practical lesson design activity. The fourth section discusses findings from this practical study. The final section concludes this paper.

1. Lesson Design Supported by OMNIBUS and SMARTIES

Figure 1 shows a screenshot of SMARTIES that displays a model of a process of learning and instruction based on OMNIBUS. In SMARTIES, the process is represented in the form of a tree-structured graph of learning goals. This structure represents the sequence of learning and instruction from left to right in a unit of learning such as a lecture or a learning session in a learning content. The root represents the goal of the unit of learning, and the bottom sequence represents concrete interaction between the instructor and the learners. A node is called “I_L event” (instructional and learning event) and a vertical link between them is called “WAY”. A tree-structured graph composed of I_L events and WAYs is called “I_L scenario model”. By the combination of these two concepts the hierarchical structure represents the design rationale of the sequence. That is to say the intention of each I_L event is represented by the upper one linked with a WAY and all the concrete interaction represented by the bottom I_L events are rationally linked to the goal of the unit of learning.

The essential of learning and instructional process model based on OMNIBUS is a distinction between learning goals and ways to achieve them. This distinction enables to manage a diversity of learning and instructional methods. There can be many methods to achieve a learning goal, and there is a method that can achieve some different learning goals. This approach can organize relationship between a variety of learning goals and methods to achieve them.

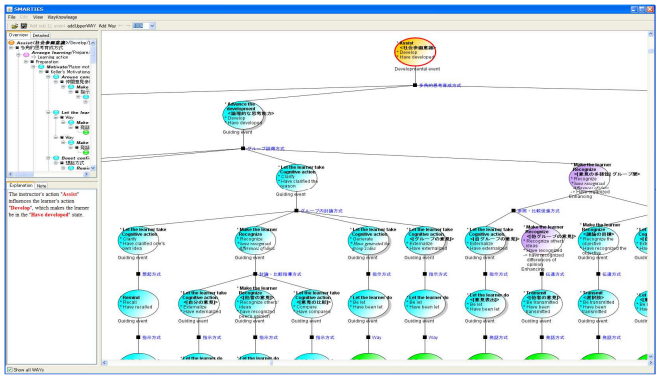

Figure 1 A screenshot of SMARTIES

2. Practice of Lesson Design with OMNIBUS and SMARTIES

The authors made some field trials to use OMNIBUS and SMARTIES in designing lessons in ToChuSha. The goal of these trials is to confirm the following hypotheses formed in this study;

1. Making I_L scenario models enables teachers to make lesson design clearer.
2. I_L scenario models help teachers to improve lesson design by considering alternative learning and instructional methods.

Previous study [4] illustrates the potential to support the former. This time, the authors made some field trials in order to find further support for the hypothesis and analyzed the results quantitatively. On the other hand, this study confirms the latter by analyzing alternative WAYs made in the I_L scenario models in these field trials.

In the field trials SMARTIES mainly played a role of a tool to describe design rationale of lessons made by teachers of ToChuSha. The major goal of the activity of ToChuSha is to make use of the results achieved up to now by them. Therefore, the priority is, rather than to make use of learning and instructional theories, to improve instructional methods they have used after clarifying the design intention of lessons. The authors repeat the following procedure in the filed trials with teachers in ToChuSha.

1. **A teacher makes a lesson plan:** the teacher designs a lesson and then describes it as a lesson plan.
2. **The author makes an I_L scenario model from the lesson plan:** the author presumes the lesson design from the lesson plan and makes an I_L scenario model.
3. **The teacher confirms the model:** the teacher checks whether the model reflects the design that the teacher has considered when he has made the lesson plan.
4. **The teacher discusses the lesson design with the author:** the teacher and the author check the validity of the design and try to improve it if desired.
5. **The teacher updates the lesson plan:** the teacher updates the lesson plan according to the I_L scenario model.
6. **The teacher discusses the lesson plan with the other teachers in ToChuSha:** the teacher suggests the plan reflecting the result of the discussion to the other teachers in ToChuSha and asks for feedback. And then go back to the second step.

In this procedure, from the second to the fifth steps are differences from the usual procedure that teachers in ToChuSha. That is, from the second to the fifth steps are the additional steps to investigate the effectiveness of OMNIBUS and SMARTIES.

The authors conducted this procedure on six lessons made by teachers in ToChuSha. Two of the lessons are for presentation at a domestic annual conference of teachers of social studies, and the others are for lesson studies in their schools or the school board. The number of times of this procedure the author could carry out differs from one lesson to another because it was necessary to follow their schedule. The highest number is five times for a lesson while there are only one or two chances for the rest.

3. Findings from Modeling Lesson Design in Practice

We officially summarized findings from the field trials with ToChuSha as follows:

A) **Clarification of the design rationale of lessons:** the design rationale that has not been described or described implicitly in the lesson plan but planed in the teacher's mind is described more explicitly in the I_L scenario model.

B) **Improvement of lesson design:** lesson designs are improved through discussions between the teacher and the author based on both of the I_L scenario models and past achievements of ToChuSha.

This section explains these findings with some data or examples. Note that the main topic of this section is not the quality of the resultant lesson plan or the originality of learning and instructional methods included in it. What we will discuss are the activities by teachers for careful consideration for improvement of lesson design.

Nevertheless some subject matter expert evaluated the resultant lesson plan. Firstly, ToChuSha authorized it. Members of ToChuSha accepted the lesson plan supported by OMNIBUS and SMARTIES, and then published it. Secondly, the teacher that has made the lesson plan demonstrated a lesson according to the plan at an annual domestic conference on

educational research of social studies in Japanese junior high schools. At the conference, there was a reviewer for the lesson demonstrated. He highly appreciated it as well-designed one with a clearly defined position in the curriculum. Consequently, although the quality of the resultant lesson design did not undergo quantitative evaluation, the quality is ensured to a certain extent because some subject matter experts properly assessed it.

In the field trials, not the teachers but the author made I_L scenario models as stated in the previous section. The teachers checked whether the author translated the original lesson plans into the models faithfully. Then, the teachers and the authors made discussion for improving the lesson design. Through this process, the teachers and the authors clarified lesson design in the teachers' mind and then improved it.

A lesson plan describes the goal of a lesson, the aim of instruction, and concrete activities of learners and teachers. It is considered that it is a description of the result of the teacher's consideration of lesson design. The consideration includes, for example, the consistency between the goal of the lesson and concrete activities of teachers and learners, alternatives of learning and instructional methods can be adopted and so on. The authors tried to expose such information that tend to be implicit in lesson plans and made I_L scenario model according to it through interviews from teachers.

Table 1 shows improvement process of the lesson plan in terms of number of items in a lesson plan and concordance between the items and the I_L scenario model made from it. This table indicates that, in essence, both of the number of items in the lesson plan and the concordance rate are increasing step by step. This can be considered that the teacher updated the lesson plan in a reflection of improvement of the lesson design described as the I_L scenario model. In fact, the teacher commented that he could update the description of the lesson plan by reconfirming the lesson design with the scenario model. Thus, this suggests that the increase of the number of the I_L events means the progression of externalization and improvement of lesson design in his mind. In addition to that, this also suggests that the increase of the number of items in the lesson plan means the reflection of changes of lesson design on the lesson plan. That is to say, repeating update of models and the lesson plan helped him to clarify and externalize the design rationale of the lesson. Furthermore, the repetition also helped him reflect the change of lesson design on the lesson plan. Consequently, this can be a case supporting both hypotheses of this study as previously mentioned.

Note that the concordance rate once decreases in the second cycle. In the first cycle, the lesson plan was a rough note, and the teacher had a difficulty to organize his idea of the lesson. Therefore, the scenario model at this time mainly had I_L events representing only the goal of the lesson and concrete interactions between teachers and learners. This caused high concordance rate yet the design rationale was not clear. On the contrary, the concordance rate in the second cycle is lower than the first one. This is also the result of improvement because there is the increase in the number of I_L events. This means the teacher has enriched the lesson design in his mind. However, the concordance rate is low because the lesson plan has not reflected enough on the lesson design yet he has expressed it when making the I_L scenario model. Thus, it suggests that, in the cycle, the teacher could update lesson plan with improvement of lesson design through making an I_L event scenario model. Finally, he made the lesson plan reflecting results of improvement of lesson design.

Table 1 Improvement process of a lesson plan and an I_L scenario model

Cycle	1	2	3	4	5
# of items in the lesson plan	17	21	22	25	31
# of I_L events in the model	73	82	94	91	91
# of concordance of the items and the I_L events	56	57	77	78	88
The concordance rate (%)	76.7	69.5	81.9	85.7	96.7

4. Conclusion

We have discussed practical experiences of the field trials the authors carried out with teachers in ToChuSha. In the field trials, OMNIBUS worked as the basis for describing design rationale of lessons and SMARTIES worked as a tool for describing them as I_L scenario model. In this study, teachers firstly made lesson plans based on their idea and then discuss for improving it with the authors. In fact, the teacher could modify lesson design or make new ideas for a lesson plan in discussion using I_L scenario model after they made the lesson plan by themselves. The quality is ensured to a certain extent because some subject matter experts properly assessed it. This can be considered as the contributions of OMNIBUS and SMARTIES in this study. As the result, this study obtained case examples supporting the hypotheses mentioned in Section 2. Of course, there is still room for argument about the comparison of the proposed approach with the others and the learning effect of lessons designed with this approach.

Some doubt remains about this result. Interpretations of lesson plan by the authors might have some influence on the result because the authors made I_L scenario model from the lesson plan. However, as stated in Section 2, the teachers confirmed the model and then discussed with the authors to improve lesson design. It should be noted that the teachers and the authors discussed continuously to improve lesson design until they finish making lesson plan. This is because they can record design rationale of each lesson plan consistently as I_L scenario model. The teachers gave comments that the record is helpful to look back on thinking when they had described the lesson plan.

The future work is to improve SMARTIES with which teachers can easily make and improve lesson design by themselves. In this study, not teachers but the authors made I_L scenario models in view of our previous study [4]. It is necessary to make OMINBUS and SMARTIES user-friendly to allow teachers can use SMARTIES by themselves.

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