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A Practical Study on Modeling Lesson Plans with an Ontological Engineering Approach

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Abstract: This paper discusses computer support for making a design of a lesson in a school teacher's mind. Although school teachers usually describes the plan in a document called lesson plan, it is the result of thought and does not often have enough information about the design rationale behind it. The authors have developed an ontology called OMNIBUS and a theory-aware authoring system called SMARTIES. The purpose of this study is to examine the effectiveness of them through the practical efforts of deploying them to a community of social studies schoolteachers. This paper presents findings of the practical efforts and considerations of improvement of OMNIBUS and SMARTIES.

Keywords: ontological engineering, authoring system, lesson plan,
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Introduction

An approach to development of teaching skill is a "lesson study" [5], in which they observe and review each other. However, this interactive approach does not always work well, and school teachers tend to educate students using their own experiences [6]. A cause of this problem is considered to come from the difficulty of externalization of thought in planing lessons.

The purpose of this study is to examine the application of ontological engineering to designing lessons in order to solve the problem mentioned above. The authors have developed the learning and instructional theories based on an ontology called OMNIBUS and a theory-aware and standards-compliant authoring system called SMARTIES [1]. Currently, the authors attempt to deploy them into lesson study groups of teachers in Tokyo. This group consisted of active teachers who are highly interested in lesson study and have experience of it and former teachers who are working in school committees to coach active teachers. This paper discusses the findings of the practical efforts and the consideration of the effectiveness of OMNIBUS and SMARTIES based on insights gained in its practical use.

The rest of this paper is structured as follows. The next section explains a proposed modeling framework and how lesson plans are described in the framework. Section 3 reports the findings of the practical efforts and considers the effectiveness of the framework, based on comments received from active teachers. Finally, the last section concludes this paper and presents future plan for this study.

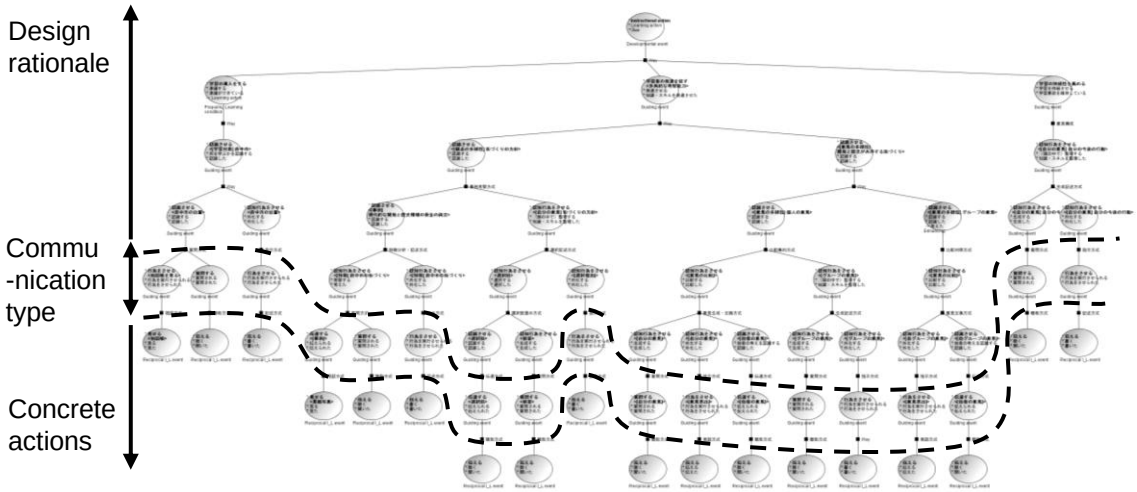

Fig. 1 An overview of an I_L scenario model.

1. Modeling Lesson Design based on OMNIBUS

OMNIBUS defines a framework for modeling the learning and instructional process, called the *learning and instructional scenario model (I_L scenario model)*. It is explained briefly here. Further details are given in [1]. As shown in Fig. 1, an I_L scenario model describes the learning and instructional process as a hierarchical part–whole structure of learning goals. The bottom of this structure represents the concrete interaction process between a teacher and students from the left to the right, and the relation from the root to the bottom represents the design rationale of the concrete process. The layers of this model are defined in [2].

This study proposes computer-understandable description of *lesson design*. By lesson design, we mean a plan of a lesson in a teacher's mind. This study propose describing lesson designs as I_L scenario models in order to clarify the design rationale included in them. Lesson design is often described in a document called *lesson plan*. A lesson plan is composed of rough plan of lessons for a course unit and the concrete plan of one of them. the concrete plan describes the schedule, learning goals, points of instruction and so on. The average length of a lesson plan is four A4 pages. Half of them are for the rough plan, and the others are for the concrete plan. Lesson plans function as media for sharing lesson designs among teachers. However, it is difficult for teachers to describe a lesson design in a document because of the length limitation mentioned above and the difficulty of externalizing thoughts in one's mind.

There are many lesson plans that mainly describe the plan of what the teacher and the students actually do and that do not have enough description about the design rationale of the plan. Table 1 shows a part of a concrete plan used in this study. This relatively describe the design rationale well because the teacher try to describe the intention of instruction in points of instruction. However, it is not enough. Through the interview with the teacher who made it and the observation of lesson conducted according to the plan, the authors found that

Table 1 Part of a lesson plan modeled in this study

	Items to be learned	Points of instruction	Evaluation (■), Methods (○)
Introduction	" Check the location of Fuchu City in the Kanto region " • Students look for Fuchu city in the Kanto region and express it in their exercise books.	• The teacher <u>calls students attention</u> to the positional relation of Fuchu City in Kanto region with comparative expression.	■ Students can look for Fuchu city in Kanto region with atlas ○ statements, exercise book

the plan misses some steps that are to inform the objective of the lesson and to remind the students of what is learned in the previous lessons.

The I_L scenario model works as a means for bridging the gap between a lesson design in a school teacher's mind and a lesson plan. This do not insist that I_L scenario models should replace lesson plans. The I_L scenario model complements a lesson plan, making the relation between the lesson design and lesson plan clear by externalizing the implicit design rationale behind the lesson plan. This also enable school teachers to analyze lesson design, such as the characteristics of each lesson design, comparisons between them, and the tendencies of instructional methods of teachers and teacher communities.

2. An Analysis of Lesson Design with I_L Scenario Models

In this section, we discuss analysis of lesson design with an I_L scenario model and teachers' responses to it. The origins of the models illustrated in this section are lesson plans made by the group of teachers cooperating with the authors. The authors made an I_L scenario models from the lesson plans with a presumption of the design rationale and then analyzed alternatives to some part of the design. The authors showed the models, analysis results, and alternatives to the teachers and discussed their validity and the usefulness of the I_L scenario model for active teachers. Although the authors made only four models, this section discusses the extraction and management of empirical knowledge of active teachers via these models.

The major advantage of making I_L scenario models is to record the design rationale of a lesson design, which is not fully described in a lesson plan. An I_L scenario model can separately deal with a learning goal and ways to achieve it because of the separation of the concepts of I_L event and WAY defined by OMNIBUS. For example, in order to make a learner recognize his/her error, a teacher can directly inform him/her or can make him/her aware of it indirectly. The former is a cognitivist way to achieve the goal, and the latter is a constructivist way. There are pros and cons to both: whereas the former is effective in achieving the goal itself, the latter is effective in generating self-reflection. In this manner, there are alternative ways to achieve a learning goal, depending on the educational policy. Organizing learning goals and ways to achieve separately them allows us to record not only the final decision but also alternatives. This helps school teachers to clarify the reason for the decision making.

Figure 2 shows an example of such a record that includes a teacher's final decision and the alternatives from a practice by the authors. The combination of WAYs (a) and (b) is the final decision described in the source lesson plan. WAYs (a') and (b') are alternatives to (a) and (b), respectively. The final decision, the combination of WAYs (a) and (b), means that a teacher presents multiple choices of typical thoughts on the topic in order to help learners make their own thoughts and then let the learners choose one as their own thought. Modeling the process as multistage decomposition by WAYs (a) and (b) is helpful in considering alternatives. In this case, the first focus of decomposition is multiple choices to be presented to students. The difference between WAYs (a) and (a') is whether or not a teacher lets the students consider multiple choices. The second focus is who makes the multiple choices. The difference between WAYs (b) and (b') is whether or not the teacher gives choices to the students when the teacher lets the students consider multiple choices.

It is noteworthy that, in this study, these differences can be described as combination of WAYs. Each WAY is modeled as a module of an instructional strategy, that is, "what to achieve" and "how to achieve". If "what to achieve" is the same between two WAYs, the WAYs can be the alternative to each other. Another notable thing is that WAYs should be described independently of a particular lesson design. If WAYs are described generically,

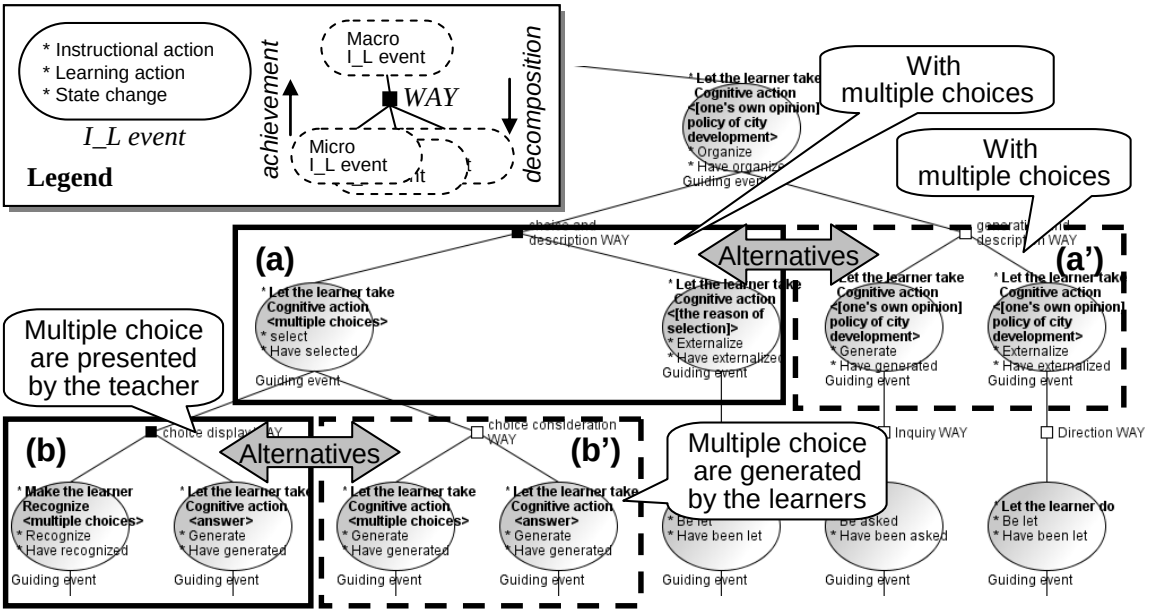

Fig. 2 Alternatives in an I_L scenario model.

they can be used in the other lesson designs including the same learning goals. Generalization of strategies will allow us to reuse both of a whole lesson design or per strategy included in it effectively.

Organizing strategies in the form of WAY is helpful to school teachers to understand the difference between not only lessons but also teaching styles. In fact, when the authors showed this I_L scenario model with alternative strategies to an active teacher that is not the same as the teacher made the source lesson plan, he explained the difference between his own educational policy and that of the teacher who made the source lesson plan. He noted that the teacher who made the lesson plan often used the strategies of WAYs (a) and (b), whereas he often used the strategies of WAYs (a) and (b'). He also said that, although he had been aware of the difference between him and other teacher, he had never fully verbalized the difference. He also suggested that this method may be helpful for disseminating instructional strategies in a community of teachers and facilitating awareness of the differences between teachers' own strategies and those of others.

3. Conclusion

This paper reports the findings of practical efforts at examining the effectiveness of OMNIBUS and SMARTIES in designing lessons. Although we do not insist on the generality of the findings because of the paucity of available data, the teachers who joined in the practical efforts gave positive comments on describing lesson design as I_L event model. Their comments suggested that modeling strategies used in a lesson design as WAYs allows us to clarify the design rationale lying behind lesson plans.

These practical efforts also revealed that what active teachers require is a system for organizing the instructional strategies of excellent teachers or strategies that have been refined in a community, rather than theoretical knowledge that the authors have accumulated so far. In response to these findings, the authors also aim to make OMNIBUS a common foundation for sharing the empirical knowledge that active teachers have accumulated. This foundation may be a circular system of theory and practice in which we can put theories into practice effectively and build theories from findings gained in practice.

Of course, it is difficult for active teachers to describe a lesson design as an I_L scenario model with OMNIBUS and SMARTIES in their current forms. In the author's

earlier study [3] and in the practical efforts reported in this paper, it took time for teachers to understand OMNIBUS and SMARTIES. It is difficult for them to describe the lesson designs behind lesson plans because they tend to make lesson designs with habitual ways of thinking. They are usually not aware of the design rationale. Therefore, the authors are planning to improve OMNIBUS and SMARTIES in terms of usability and to add functions for reducing the cognitive load on teachers in terms of meta-cognition [4]. The former includes not only refining the user interface of SMARTIES but also developing a method of managing OMNIBUS and SMARTIES. In the latter, it is necessary to consider support functions for helping teachers to externalize the lesson designs in their mind and to promote self-reflection.

An even broader goal of this study is to strengthen the solidarity of communities of teachers in terms of knowledge sharing. Currently communities of teachers are mainly organized by subjects. For example, the subject of the community that we have collaborated with is social studies. Furthermore, in social studies, there are the three areas of civics, geography, and history, and each area tends to develop its own instructional methods. Of course, each area needs its own methods that depend on the subject. However, through these practical efforts, we consider that there are two types of instructional method; One can be shared beyond subject boundaries and the other is specific to the particular subject. We are planning to conduct a survey of pilot schools with regard to such cross-subject instructional methods. In pilot schools, teachers conduct cross-subject discussions with each other, and this appears to be a suitable scenario for considering the generality of instructional methods.

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