Practical Use of Visualizing Lesson Structures in Teacher Training Education and Its Effectiveness

Toshinobu KASAI[a*], Kazuo NAGANO[b] & Riichiro MIZOGUCHI[c]
[a]*Okayama University Graduate School of Education Master's Program, Japan*
[b]*Faculty of Liberal Arts, University of the Sacred Heart, Japan*
[c]*Research Center for Service Science, Japan Advanced Institute of Science and Technology, Japan*
*kasai@okayama-u.ac.jp

Abstract: We have built an instructional design support system called "FIMA-Light" which uncovers teacher's intentions from his/her lesson plan and automatically visualizes them as goal decomposition trees. A decomposition tree expresses the ways of achieving a learner's state change that should be realized in a whole lesson in the form of a tree structure. We have made use of FIMA-Light so that incumbent teachers themselves can improve their lessons. In this paper, we report on a practical use of goal-decomposition trees produced by FIMA-Light to improve trainee teachers' skills in designing instructions before teaching practices in the teacher education program, and we discuss its effectiveness.

Keywords: Instructional Design, Ontology, Teacher Training, Teachers' Professional Ability

1. Introduction

Alignment between teaching practices in schools and teacher training education provided at university is an important aspect in improving teacher education programs (The Central Education Council, 2015). However, almost all universities provide only abstract descriptions in their policies, such as "Bridging Theory and Practice" (Department of Teaching & School Leadership, Okayama University, 2013; Fujimura & Sakanashi, 2010; Graduate School of Teacher Education, Waseda University, 2013) about the alignment between teaching practices and university education. The importance of and difficulty involved in achieving alignment between university education and teaching practice have also been reported in countries other than Japan (Smith, 2004; Curriculum Center for Teachers, 2012). In this study, we examined the ability of teachers to instruct learners (the ability to properly design and practice instruction). We also clarified the respective roles of teaching practice and university education in teacher education programs, as well as the relationship between them (Kasai, Nagano & Mizoguchi, 2013). The principal difference between them is whether real students are present in front of the university students (trainee teachers). Thus, it is difficult for them to design a detailed lesson in university education, because they cannot imagine concrete learners (Kouno et al., 1998, See 3.2 in this paper: we found two types of problems included in the lesson plans which university students designed.). We identified the following two problems when university students design lessons in university education.

- Since it is difficult for university students to predict learners' diverse actions, it is difficult to plan the concrete reactions that teachers should follow in a lesson.
- Since it is difficult for them to imagine the learning processes of general learners concretely, it is difficult to envisage the detailed flow of learners' state changes, which are the sub-goals in a lesson and to plan concrete strategies to attain the sub-goals.

To solve the former problem, some methods that aim to allow university students imagine concrete diverse learners have been proposed (i.e. Microteaching (Allen and Ryan, 1969, Clifford, Jorstad and Lange, 1977), and Simulation of Instruction (Kubota, Suzuki and Mochizuki, 2014). On the other hand, to the best of our knowledge, there is no approach that aims to solve the latter problem, and therefore, we aim to solve the latter problem. To solve this problem, it is necessary for university students to design instructional strategies concretely for attaining the educational goals in all learners. Therefore, it is important to allow them to imagine general learners and their learning processes concretely. However, since it is difficult for university students to imagine general learners concretely, it is difficult for them to envisage the detailed flow of learners' state changes that are sub-goals in a lesson. As a result, in university education, students often design insufficient lessons that contain no concrete strategy for attaining sub-goals (for example, "Learners are interested in an object"). It is necessary for university students to learn the skill required to design detailed concrete flows of instructional and learning activities in university education. Here, to attain an overall goal in the whole lesson, every concrete strategy for attaining sub-goals has to be related to the global strategy for attaining the overall goal. Therefore, it is necessary for teachers to have skills in designing lessons that integrate a global strategy and local strategies. From this consideration, in university education, in which there are no real learners, we identified the following two main goals that university students should aim to achieve.

- To understand that there are various strategies (flows of instruction and learning) for students to attain the educational goals.
  - To understand learning/instructional theories and expert teachers' knowledge gained from practice.
- To improve their skills in designing lessons that integrate a global strategy for attaining an overall goal in the whole lesson and local strategies for attaining sub-goals.
  - To improve their skills in designing lessons that contain detailed concrete strategies for attaining sub-goals.
  - To improve their skills in assessing every learning/instructional activity in terms of attainment of an overall goal and sub-goals.

To allow university students learn these skills efficiently, it is necessary to express all learning/instructional theories and practical knowledge with a common format. A representation format that will help university students to think about strategies in their lessons from global to local viewpoints is required. We considered that the I_L event decomposition tree (described in 2.1), which defined based on the OMNIBUS ontology (Hayashi, Bourdeau, & Mizoguchi, 2009), might be suitable for such university education. We think that the goal of their university education should be to let university students learn the skills needed to produce not only lesson plans but also I_L event decomposition trees. Since university students cannot think in the structure of lessons, it is difficult for them to produce I_L event decomposition trees. We have proposed the use of a system called "FIMA-Light" (Kasai, Nagano and Mizoguchi, 2011) which automatically produces I_L event decomposition trees. In that study, we showed that the I_L event decomposition trees that FIMA-Light produces had effective information for university education in a teacher training course. In this paper, we report the results of practical use of FIMA-Light in a university lecture in a teacher training education course.

The remainder of this paper is structured as follows: In Section 2, we describe the features of our study that can overcome the above difficulties in teacher training education. In Section 3, we report the results of the practical use of FIMA-Light in the lecture in university education. This is followed by a discussion of some related work and concluding remarks in Section 4.

2. Features of our Approach

In this section, we explain the I_L event decomposition tree and FIMA-Light which we propose for practical use in university education in order to solve the problems described above.

2.1 The I_L event decomposition tree and its features

In the format of a "lesson plan", teachers describe the learning activity, instructional activity, evaluation method, and points to consider while teaching in every scene of their lessons. This format is generally used also in teaching practices. Therefore, it is important for trainee teachers to learn how to describe their plans for their lessons in the format of a lesson plan before their teaching practices. However, since a lesson plan describes mainly superficial concrete activities, it is difficult for university students to consider strategies to be applied in the lesson from global to local viewpoints. Therefore, we think that effective instruction in university education cannot be realized using only the lesson plan as a format to represent lessons. Another representation format that will help university students to think from a more global viewpoint is required.

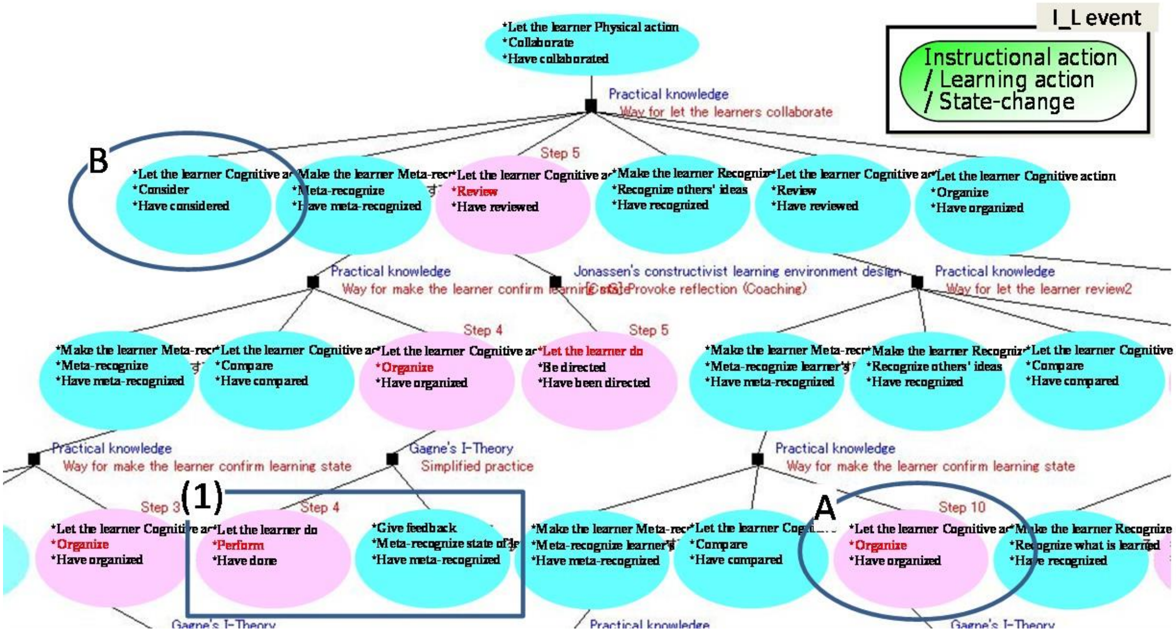

Figure 1. An example of an I_L event decomposition tree and its structure.

We considered that the I_L event decomposition tree, which is defined based on the OMNIBUS ontology (Hayashi, Bourdeau, & Mizoguchi, 2009), might be suitable for such university education. The OMNIBUS ontology has been constructed to organize a variety of learning/instructional theories and empirical knowledge extracted from best practices independently of learning paradigms. The core concepts of the OMNIBUS ontology are an I_L event and its decomposition structure which we call a goal-decomposition tree earlier. An I_L event is a basic unit of learning and instruction and is composed of a state change of a learner, an instructional action, and a learning action. A method for realizing the state change (macro I_L event) is expressed by a decomposition relation with multiple micro I_L events, called a WAY. In the OMNIBUS ontology, every piece of knowledge extracted from learning/instructional theories and practices can be described as a WAY. A macro I_L event is decomposed into several micro I_L events by applying a WAY. With this modeling framework, the flow of a lesson is modeled as a tree structure of I_L events that is called an I_L event decomposition tree. The root node of the decomposition tree is an I_L event that shows the intended learner's state change that should be realized in the whole lesson. In the decomposition tree, higher layers express instructional strategies of more global viewpoints. And by decomposing these into lower layers, this decomposition tree can express instructional strategies of more local viewpoints.

These features of the OMNIBUS ontology and the I_L event decomposition tree can solve the problems caused by the lack of a unified representation format for various strategies.

2.2 Overview of FIMA-Light

FIMA-Light knows several original concepts and let instructors select one among them appropriate for each scene in the flow of their lesson plans to understand and manipulate users' lesson plans. We have prepared a set of 36 such concepts which teachers are familiar with, through discussion with a couple of teachers. And, we classified the FIMA-Light's activity concepts into three classes: one class of concepts of instructional activities and two classes of concepts of learning activities ("shallow-level learning activities" and "deep-level learning activities"). By shallow-level learning activities, we mean concrete actions which often appear in lesson plans (e.g. "Discuss," "Listen"), and by deep-level learning activities, we mean cognitive actions which rarely appear in lesson plans (e.g. "Raise motivation," "Recognize state of learning"). In order to enable FIMA-Light to understand lesson plans input to FIMA-Light, instructors select a concept out of 10 concepts prepared as instructional activities (e.g. "Explain," "Ask"), a concept out of 11 concepts prepared as shallow-level learning activities, and a concept out of 15 concepts prepared as deep-level learning activities, for each step in the flow of lesson plans.

To make use of WAYs described in the OMNIBUS ontology, FIMA-Light translates FIMA-Light's activity concepts into the action concepts defined in the OMNIBUS ontology (approximately 250 concepts). For realization of the translation, we described the mapping relation between FIMA-Light's concepts and OMNIBUS action concepts. For example, the mapping relation between the concept "Raise motivation" in FIMA and 11 concepts ("Raise aspirations," "Recognize the relevance," "Feel familiarity," and so on) which are defined in the OMNIBUS ontology was described. Based on the description of the mapping relation, FIMA-Light can translate FIMA-Light's activity concepts selected by instructors into OMNIBUS action concepts.

In OMNIBUS, I_L event decomposition trees are made by teachers by decomposing how to achieve learners' state change in the whole lesson in a top-down manner. In contrast, FIMA-Light produces I_L event decomposition trees in a bottom-up manner by interpreting the sequence of concrete-level instructional and learning activities described in lesson plans. Analogically, we can say that FIMA-Light builds a syntax (parse) tree of an action sequence in the lesson plan as a sentence by parsing it. So, when FIMA-Light produces I_L event decomposition trees, it is automatically adds hypothetical I_L events at higher levels of abstraction to show underlying intention (intermediate goals) than is described in usual lesson plans. FIMA-Light produces I_L event decomposition trees following the procedure described below after translating FIMA vocabulary selected by instructors into several related concepts defined in the OMNIBUS ontology. FIMA-Light

1. extracts WAYs relevant to each step in the flow of the lesson plan, and develops decomposition sub-trees that have hypothetical root nodes by applying the WAYs,
2. produces all I_L event decomposition trees appropriate for the given lesson by configuring appropriate sub-trees developed above, and
3. determines an I_L event decomposition tree that fit well with the lesson plan by calculating degrees of similarity of every decomposition tree to the lesson plan.

The current version of FIMA-Light produces I_L event decomposition trees based on 100 Ways that were extracted from learning/instructional theories and 20 Ways that were extracted from actual lessons. An example I_L event decomposition tree that FIMA-Light produced by interpreting an actual lesson plan is shown in Figure 1. An I_L event decomposition tree includes two kinds of nodes. One type includes pink nodes that show I_L events which FIMA-Light judged corresponding to the lesson plan (e.g. "A" in Figure 1). The other type includes blue nodes that show I_L events that FIMA-Light judged not to correspond to any scenes explicitly described in the lesson plan (e.g. "B" in Figure 1). The aim of FIMA-Light is to help teachers to deeply reflect on their lesson plans by providing them with the I_L event decomposition trees. In practical use for teacher education, thanks to the I_L event decomposition trees provided by FIMA-Light, teachers could find, on average, 2.5 points that could be improved in each lesson plan.

In practical use of FIMA-Light in the past, we had provided teachers with I_L event decomposition trees to help them to deeply reflect on their lesson plans. However, helping university students to deeply reflect on their lesson plans did not provide a useful effect in their learning, because university students could not think appropriately in designing lessons. Therefore, we used FIMA-Light in the university lectures of teacher training education with the following two aims.

- To improve university students' awareness that a lesson has not only an overall goal but also various sub-goals.
- To improve their awareness that every learning/instructional activity has a role in attaining an overall goal and sub-goals in the lesson.

3. Use of FIMA-Light in the University Lecture

3.1 Purpose and Outline of the University Lecture in which We Used FIMA-Light

The lecture in which we used FIMA-Light was "Studies on Information Study Method A", given at the Faculty of Education that one of the authors of this paper belongs to. This lecture was open to university students studying in the Faculty of Science, the Faculty of Engineering, and the Faculty of Environmental Science and Technology and who would like to become teachers. Eleven students attended this lecture in 2015. All students had learned how to write lesson plans in other lectures but had no experience of teaching practice. The educational goal of this lecture was to let them learn the skills required to design instruction on the subject "Information" in high school. Figure 2 shows the flow of the lecture (five classes) in which we used FIMA-Light.

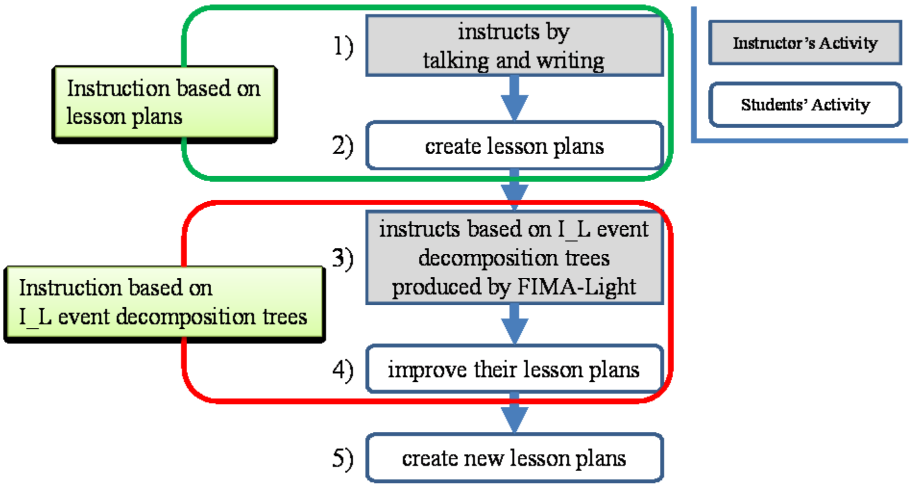

Figure 2. The flow of the lecture in which we used FIMA-Light.

In step 1), the instructor provided the university students with four actual lesson plans (on the subject "Information") that incumbent teachers had created and instructed them on how to describe a lesson plan. In particular, the instructor emphasized the following three points to pay attention to and provided the university students with a document in which these points were described.

- To describe a concrete flow of the lesson which can be practiced.
- To be aware of not only the overall goal but also sub-goals in the lesson.
- To be aware of that every learning/instructional activity should have roles in attaining the overall goal and sub-goals in the lesson.

In step 2), the instructor directed the university students to create lesson plans. And, to make them aware of the third point described above, the instructor directed to the students describe what teachers should consider in each scene of the lessons to attain the overall goal of the whole lesson or the sub-goals. The instructor showed an example of the description "To make learners interested in a problem, the teacher should make them consider the relevant information".

In step 3), the instructor inputted the data of all lesson plans into FIMA-Light and provided every university student with the I_L event decomposition tree that FIMA-Light produced. Then, the instructor specified each scene in the lesson plans that FIMA-Light judged to correspond to pink nodes in the I_L event decomposition trees. The instructor explained the I_L event decomposition tree and instructed the students on the three points emphasized in step 1) by using the I_L event decomposition trees.

In step 4), the instructor instructed the university students on how to improve their lesson plans by referring to the I_L event decomposition trees, and directed them to improve their lesson plans. This instruction is explained concretely in Section 3.2. The purpose of this step was not to evaluate the effect of instructions by using the I_L event decomposition trees, but to let the university students experience creating lesson plans in consideration of three points emphasized in step 1).

In step 5), the instructor directed the university students to create new lesson plans. And, in the same way as in step 2), the instructor directed them to describe what teachers should consider in each scene of the lessons to attain the overall goal of the whole lesson or sub-goals. The effectiveness of making use of FIMA-Light was evaluated by using the following three steps.

A) We analyzed the lesson plans that the university students created in step 2) by comparing them with lesson plans created by incumbent teachers and university students who had experience of teaching practices.

B) We compared and analyzed the lesson plans that the university students created in steps 2), 4), and 5).

C) We qualitatively analyzed the lesson plans that they created in step 5).

3.2 Results of the Practical Use of FIMA-Light and Its Evaluation

Table 1 shows the results of step A). We investigated 11 lesson plans created by the university students in step 2), 10 lesson plans created by the university students who had experience of teaching practices, and 10 lesson plans created by incumbent teachers. As a result of the investigation, the number of scenes in lesson plans created by university students after teaching practices was significantly less than the number of scenes in lesson plans created by the incumbent teachers (t-test: t=3.64, df=18, p=0 .002). Moreover, the number of scenes in the lesson plans created by the university students in step 2) before their teaching practices was significantly less than the number of scenes in the lesson plans created by university students after teaching practices (t-test: t=2.11, df=19, p=0.049). From this result, we could confirm that (trainee) teachers who had less experience can describe less-detailed lesson plans. By analyzing the lesson plans created in step 2), we could find two types of problems included in the lesson plans. The first problem is that, though an internal activity of learners (e.g. “learners notice the importance of a problem”) is described in the lesson plan, a strategy to attain it is not described. We considered that one cause of this type of problem is that it is difficult for university students to recognize the internal activity (state change) as a sub-goal in the lesson. The second problem is that, though a teacher has learners perform an activity in the lesson, the goal that the teacher intends to attain by the learning activity is not clearly described in the lesson plan. Therefore, in such lesson plans, the goal that the teacher intends to attain by the discussion and presentation is not clearly described. We considered that one cause of this type of problem is that it is difficult for university students to be aware of sub-goals that are attained by every concrete learning activity. These two problems can be expressed in the framework of the I_L event decomposition tree. The first problem can be expressed in a situation in which a node that shows a learner’s internal state change is not decomposed into more concrete nodes. The second problem can be expressed in a situation in which some of the nodes produced by decomposition to attain a node that shows a sub-goal in the lesson contains blue nodes. Although FIMA-Light cannot always produce I_L event decomposition trees that include such all problems by interpreting lesson plans, in this practical use, some problems were expressed in the I_L event decomposition trees. An example that FIMA-Light actually expressed a problem in the I_L event decomposition tree is shown at "(1)" in Figure 1. In this example, a macro I_L event ("learners organize their opinions") that is sub-goal in the lesson is decomposed into two micro I_L events ("teacher lets learners do an activity" and "teacher gives feedback to learners") to attain the sub-goal. FIMA-Light judged the I_L event ("teacher lets learners do an activity") corresponding to the lesson plan. However, FIMA-Light judged the I_L event ("teacher gives feedback to learners") not to correspond to any scenes

Table 1. The features of the lesson plans created by the university students

	Average (Variance) of the number of scenes of lesson plans	The maximum number of scenes	The minimum number of scense
10 lesson plans by teachers	10.60 (0.93)	12	9
10 lesson plans by university students after teaching practices	8.70 (1.79)	11	6
11 lesson plans by the university students before teaching practices	7.18 (3.79)	11	5

explicitly described in the lesson plan. This is the example that FIMA-Light extracted the second problem which we described in above. Based on these considerations, in step 4), the instructor directed the university students to improve their lesson plans referring to the I_L event decomposition trees by using the following three steps.

- To confirm about every learning activity (especially internal activity) in his/her lesson plan whether it is necessary to add strategy to attain the sub-goal that is to let learners do the activity.
- To think what a sub-goal that should be attained by each learning activity is, and to confirm whether it is necessary to add learning/instructional activities before or after the activity to attain the sub-goal.
- To be aware of that every learning/instructional activity should have roles to attain an overall goal of the whole lesson and sub-goals in his/her lesson plans, and to describe what teachers should consider in every scene of his/her lesson to attain the overall goal and sub-goals.

Table 2 shows the results of step B). We investigated the number of scenes and the number of descriptions of relations between learning/instructional scenes and attainment of the overall goal or sub-goals in the lesson plans that the university students created in steps 2), 4), and 5). At first, we consider the number of descriptions related to goals in the lesson plans that were created in step 2). Although the instructor emphasized that every learning/instructional activity should have roles to attain goals in the lesson plans, the university students described what teachers should consider in only 33.0% of scenes to attain goals in the lessons. In particular, they could hardly describe what teachers should consider to attain sub-goals. This result shows that it is difficult for the university students to recognize sub-goals of the lessons explicitly by traditional instruction in university education. This is an important problem in the teacher training education in university education.

The number of scenes and the number of description of relations between learning/instructional scenes and attainment of goals of the lesson plans that were improved in step 4) were improved by instructing how to improve their lesson plans concretely. However, the rate of the number of scenes that the university students described relations with attainment of goals was not improved enough (72.9%), even though the instructor directed them to describe in every scene of the lessons in step 4). Here, in the lesson plans created by the university students, some descriptions that include plural learning/instructional scenes in a sentence existed. Since they could not separate such sentence into plural scenes, the number of descriptions of relations with attainment of goals was less than the number of scenes. By analyzing the lesson plans improved in step 4) in consideration of this point, we could confirm that the university students described relations between almost all scenes and attainment of goals in the lessons. Therefore, they could create lesson plans that attain three points of attention that the instructor emphasized by instruction in steps 3), 4) based on the I_L event decomposition trees that FIMA-Light produced. We can predict that a similar result will be given to them by instructing each lesson plan carefully like instruction in teaching practice. However, it is difficult to realize the instruction in a lecture of university education, because it is necessary for an instructor to spend much time for each university student. In the lecture of university education in which we made use of FIMA-Light, the instructor could instruct all university students in abstract level at the same time by using one I_L event decomposition tree that FIMA-Light automatically produced. Therefore, we think that our approach is significantly meaningful.

The number of learning/instructional scenes of the lesson plans that the university students created newly in step 5) was 9.27 on average. After the instruction, in step 5), the university students

Table 2. The result of the investigation of the lesson plans created by the university students

Average of 11 lesson plans	The number of scenes	The number of descriptions related to the overall goal (Rate of the number of scenes)	The number of descriptions related to sub-goals (Rate of the number of scenes)
Lesson plans created in the step 2)	7.18	1.91 (26.6%)	0.45 (6.0%)
		2.36 (33.0%)	
Lesson plans improved in the step 4)	9.73	3.82 (39.3%)	3.27 (33.6%)
		7.09 (72.9%)	
Lesson plans created in the step 5)	9.27	3.09 (33.3%)	2.09 (22.5%)
		5.18 (55.9%)	

learned to create detailed lesson plans at the same level as the lesson plans that university students created after their teaching practices (*t*-test t=0.95, *df*=19, *p*=0.35, n.s.). Although we cannot claim the effectiveness with statistical significance, the results obtained are encouraging, and hence we would like to explore this topic further in the future. And, the number of descriptions of relations between learning/instructional scenes and attainment of goals in the lessons was 5.15 on average (55.9% of scenes). By analyzing the lesson plans created in step 5) in consideration of above point, we confirmed that 20% of scenes were not described relations with attainment of goals. In particular, the number of description of relations with sub-goals of the lesson plans created in step 5) greatly decreases in comparison with the lesson plans improved in the 4). Therefore, we think that the university lecture could not let the university students improve their skills enough that they should learn in university education. However, for the university students that had no experience of teaching practices, we think that the instruction based on the I_L event decomposition tree produced by FIMA-Light could give effectiveness to them more than traditional ways.

Finally, we discuss the results of step C). Here, we show concrete description of an actual lesson plan created by the university students in step 5), and consider the effectiveness of instructions of the university lecture. The overall goal of a lesson plan created in step 5) was to become able to practice appropriate collection of information in the information society. In this lesson plan, there were the following two descriptions of relations between learning/instructional scenes and sub-goals of the lesson.

- To make learners consider the features of the Internet to collect information appropriately
- To make learners aware of merits and demerits of the Internet to collect information appropriately

The teacher intend to attain the same sub-goal ("to collect information appropriately") by two learning/instructional activities (scenes). These descriptions show that the university student who created this lesson plan was explicitly aware of the sub-goal of this lesson and a strategy to attain the sub-goal. We could confirm some such descriptions in the lesson plans created by the university students in step 5). These descriptions shows the effectiveness of the university lecture by using FIMA-Light.

4. Related Work and Concluding Remarks

We have built an instructional design support system called FIMA-Light based on the OMNIBUS ontology. FIMA-Light can automatically produce I_L event decomposition trees from teachers' lesson plans. We have previously evaluated FIMA-Light in practical use by incumbent teachers. In the present study, we reported the results of practical use of FIMA-Light in a university lecture in teacher training education. In university education, since it is difficult for university students to imagine learning process of general learners concretely, it is difficult to envisage detailed flow of learning/instructional scenes. To solve this problem, we used the I_L event decomposition trees which FIMA-Light produced from their lesson plans to make them be aware of not only an overall goal but also various sub-goals in the lesson. By using FIMA-Light in the university lecture, the university students learned to create detailed lesson plans at the same level as the lesson plans that university students created after their teaching practices.

Here, we would like to discuss some related work on a system known as SMARTIES (Hayashi, Bourdeau, & Mizoguchi, 2009) to contrast it with FIMA-Light. SMARTIES is an authoring system that aims to support teachers in designing learning/instructional scenarios based on the OMNIBUS ontology and that is compliant with the standard technology of IMS Learning Design. By using SMARTIES, teachers can make I_L event decomposition trees that are compliant with learning/instructional theories through deeply reflecting on the design intentions of their lessons. In addition, SMARTIES can suggest WAYs, described in the OMNIBUS ontology as strategies for achieving state changes in learners. In this approach, in which teachers employ a so-called top-down method, when they design scenarios, they have to think about deep intentions that they may not usually be explicitly aware of. For such instructional design, it is necessary for teachers to think deeply about the lessons from global to local viewpoints. Therefore, though this approach is effective for expert teachers, it is very difficult for novice teachers and university students (trainee teachers) to employ.

On the other hand, our approach employs a bottom-up method and can automatically produce I_L event decomposition trees through reasoning about teachers' design intentions from given lesson plans that they usually design. With our approach, therefore, even novice (trainee) teachers can participate in this process. This is one of the features of our approach. To support incumbent teachers, FIMA-Light does not directly improve, or tell them how to improve, their lesson plans by itself, because such support would prevent teachers from improving their professional skills. Therefore, by providing teachers with the I_L event decomposition trees that is produces, FIMA-Light aims at letting them themselves think about how to improve their lessons and in what respects. However, to support university students (trainee teachers), even though FIMA-Light provides them with I_L event decomposition trees, we cannot expect that they will recognize their underlying intentions. So, in university education, FIMA-Light aims at letting them be aware of sub-goals and strategies to attain the sub-goals. To the best of our knowledge, there is no system that can automatically reason sub-goals of the lesson as teachers' deep-level intentions from their designed lesson plans.

The purpose of university education that we proposed in this study is to provide university students with the ability to make I_L event decomposition trees themselves through thinking deeply about their lessons. Therefore, we think that, in the final stages of their university education, SMARTIES rather than FIMA-Light can support them more effectively. In future work, we intend to clarify how FIMA-Light should be utilized in university education in order to let university students efficiently attain the educational goals for teacher training education. In particular, in order to realize an alignment between university education and teaching practice based on the I_L event decomposition, we intend to examine the following two topics: 1) the generation of suitable feedback based on I_L event decomposition trees produced by FIMA-Light, and 2) the spread of the I_L event decomposition tree among teachers who will instruct university students in their teaching practices.

Acknowledgements

This work is supported in part by Grant-in-Aid for Young Scientists (B) No. 16H03077 from the Ministry of Education, Culture, Sports, Science and Technology, Japan.

References

Central Education Council (2015). How the teacher training education should be conducted in the future. Home Page of Ministry of Education, Culture, Sports, Science and Technology, Japan, http://www.mext.go.jp/b_menu/shingi/chukyo/chukyo0/toushin/1365665.htm.

Department of Teaching & School Leadership, Okayama University (2013). The purpose of Department of Teaching & School Leadership, Home Page of Department of Teaching & School Leadership, Okayama University, http://ed-www.ed.okayama-u.ac.jp/~kyoujissen/gaiyo_mokuteki.html

Fujimura N., & Sakanashi M. (2010). Teaching profession special training for the improvement of practical teaching skills required of the teachers, Journal of educational research / Center for Educational Research and Training, Kyoto University of Education, Vol.10, 221-230.

Graduate School of Teacher Education, Waseda University (2013). Three Policies of Graduate School of Teacher Education. Home Page of Graduate School of Teacher Education, Waseda University, http://www.waseda.jp/ted/eng/about/outline/policy.html

Smith, S. J. (2004). The Bearing of Inquiry in Teacher Education. The S.F.U. Experience, Vancouver: Faculty of Education, Simon Fraser University.

Curriculum Center for Teachers (2012). Project Report on Comparative Study on the Role of Schoolteachers in the Initial Teacher Education, http://www.u-gakugei.ac.jp/~currict/data/reports/s2_international/schoolteacher.pdf

Kasai T., Nagano K., & Mizoguchi R. (2013). Effective Alignment between University Education and Teaching Practice through Automatic Interpretation of Lesson Plans, *Proceedings of ICCE2013*, 158-160.

Kouno S., Souma T., Ueno M., Gotoh T., Nakamura N., Miyadera Y., and Yokoyama S. (1998). Design of a Computer Supported System to draw up Teaching Plans. IEICE technical report, ET98-81, 67-74

Allen, D. W. & Ryan K. (1969). Microteaching. Addison-Wesley, Reading, Massachusetts.

Clifford, R.T., Jorstad H.L., and Lange D.L. (1977). Student Evaluation of Peer-Group Microteaching as Preparation for Student Teaching, Modern Language Journal, 61(5-6), 229-236.

Kubota Y., Suzuki H., & Mochizuki T. (2014). Improvements of Lesson Plans by Cartoon-Based Teaching Simulation in Pre-service Teacher Training, Japan Journal of Educational Technology, 37(4), 469-478.

Hayashi Y., Bourdeau J., & Mizoguchi, R. (2009). Using Ontological Engineering to Organize Learning/Instructional Theories and Build a Theory-Aware Authoring System, *International Journal of Artificial Intelligence in Education*, Vol.19, No.2, 211-252.

Kasai T., Nagano K., & Mizoguchi R. (2011). Instructional Design Support System Based on Both Theory and Practice and Its Evaluation, *Proceedings of ICCE2011*, 1-8.