Development of a System that Supports Teachers of IT Education in the Instructional Design Process based on Ontology

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Abstract: A goal of IT education is to enable students to acquire the ability of using information in order to live in a modern information-oriented society. Such meta-ability cannot be learned in the traditional Japanese instructional way of knowledge being transmitted by teachers. When a teacher designs a lesson plan for IT education, it is necessary to include not only the target goal of the unit but also other related goals determined by types of teaching tools and teaching materials. The purpose of this study is to support the teacher of IT education in the process of designing the lesson plan. For this purpose, we propose a process for instructional which is adapted to IT education. And, we develop a system which supports the teacher in setting tangible goals in the instructional design process.

Introduction

In Japan, teaching of the subject "Information" has started in high school from April 2003. However, most of the teachers who will deliver "Information" are the incumbent teachers of subjects because there are very few specialist teachers of "Information" as of April 2003. Because of this, we can imagine a situation where most of the teachers who instruct the subject "Information" do not have enough skill of teaching the topic. Furthermore, it is difficult to learn the knowledge/skill that is necessary for teachers of information, because the concepts of the educational goals and the situations for education are not clearly defined for the subject "Information". For example, most of the teachers who are not specialists mistakenly believe use of technology itself is the main goal of IT education though using information systems is indispensable to IT education.

Many instructors and researchers have published opinions about the various concepts of IT education and relationships between them (Ministry of Education, 2000, The Meeting of Tuesday, 2002). Most of these opinions showed factors which are useful for the usual instructional design process, such as situations and contents of education, in order to attain the educational goal. But it is also necessary, in the subject "Information", to add other educational goals which are related to the main goal of a unit, according to the contents of education and the situations of education too. Because, the main goal of the subject "Information" is an enhancement of the meta-ability to make use of information in the various situations. This problem can be solved by teachers who have technical knowledge about information due to their prior learning and experiences. But for teachers who are not specialists in information technology, it is difficult to even understand this problem.

In this research, first we identify features of the subject "Information", by comparing it with other subjects, and propose an instructional design process model which is suitable for this subject. Next, we express the concepts which compose instruction, the concepts of the subject "Information" and the relations between them, clearly and systematically based on ontology theory. Finally, we develop a system which supports the teacher of the subject "Information" to set goals in the instructional design process based on these concepts.

The features of the subject "Information" and the instructional design process

In this chapter, we examine the features of the subject "Information" and propose an instructional design process model which is suitable for these features. First, we show the features of the subject "Information" which were found by comparing it with other high school subjects in the following:

- The importance of meta-ability is higher in the educational goal, and contents of education are decided for achieving it.
- The meta-ability (the ability which it makes use of information for) is a main goal, and an instructional form based on the constructivism is more important.

The reason for these features is that most educational goals of the subject "Information" are meta-ability, so it is difficult for children to attain this by transmission of the knowledge by teachers. An instruction form based on the foundation that students learn the necessary ability themselves in each given situation is effective.

The instructional design process model

An instructional design process model by Gagne is typical of one of the models presented so far (Gagne, 1979). This instructional design process model is composed of four levels. The instructional design process in this study focuses on the process that is involved from decision of the goal for a unit up to preparation of the lesson plan in the level of the instruction. The instructional design process of Gagne's model has five steps. These steps are 1,2,3,4 and 7. These meanings of the numbers are shown below:

1. The decision regarding the goal of the instruction.
2. The decision regarding the contents of the instruction.
3. The decision concerning the situation of the instruction.
4. The choice of the media for the instruction.
5. The addition and choice of the goal of the instruction.
6. The reselection of contents of the instruction.
7. The preparation of the lesson plan.

However, in the design process of the instruction, it is not only necessary to decide the instructional situations to attain the goal of a unit but also necessary to add the goal of the instruction which relates to its situations and the teaching materials based on constructivism. The Ministry of Education in Japan says that to deliver the several contents which relate to each other with the same teaching materials, across the unit, is also important (Ministry of Education, 2000). Therefore, the step to add a goal of instruction according to the instructional situation and the teaching materials in the instructional design process is necessary too. For these reasons, we propose the instructional design process model which has the seven steps 1,2,3,4,5,6,7. In this model, two steps are added to the above model.

We think that this instructional design process can provide for a more effective instruction design whereby students can not only enhance the ability stipulated in a unit but also enhance other necessary abilities in the situations given. This is very important to attain the main goal of the subject "Information", that is, to enhance the ability to use information according to each situation.

The expression of the instructional model of the subject "Information"

The ontology of the structure of the instruction

In this section we show the component concepts, which make up the instruction designed in the proposed instructional design process, that were described based on ontology theory. Here, we explain the

ontology simply. The ontology clearly shows the concepts and the relations which exist between them and gives their specific semantic definitions. Because of this, ontology promotes reclamation and joint ownership of the concepts and the models which were described with these.

The ontology of the structure of the instruction shows the contents which comprise the instruction of one unit. This ontology shows the concepts for expression the layered structure of this model. In this ontology, Development of the instruction is described with a purpose of the learner's activities and a purpose of the teacher's activities. These are the main features of the ontology that we propose in this study for the development of the instruction. The development of the instruction has been described with regard to both the learner's and the teacher's activities in most instructional models. But, it is expressed with the goals of education in this study. These show the goals of education that a teacher expects learners to attain. And they can be described for each stage of the instruction in addition to the main goal of a unit.

It is important for teachers to be clearly conscious of the goals of education underlying the learner's activities when they design the instruction based on constructivism. For this reason, this ontology of the structure of the instruction is focused on the goal of education.

The ontology of IT education

In this section, we describe the ontology of IT education which clearly expresses the concepts that compose IT education. The ontology of IT education is composed of a goal of IT education and a content of IT education. This ontology shows all contents which is used in our proposed process model. A content of education means the contents of education of the subject "Information" which the Ministry of Education has prescribed. A goal of IT education is composed of three viewpoints which are decided by the Ministry of Education. We extracted lower concepts for more than three viewpoints based on the course of study which was prescribed by the Ministry of Education. The concepts shown in this figure are used to describe an instructional model for IT education which is based on the above ontology of the structure of the instruction.

Thanks to these ontologies, we can support teachers designing the instruction in our proposed process model.

The features of the instructional model that is expressed based on two ontologies

Here, we explain the features and the advantages of the instructional model which is described based on the two ontologies above. We presume that the teacher describes this model before preparation of the lesson plan. Its advantages are shown in the following:

- The teacher can describe the goals of education in each learning activity aside from the goal of a unit.
- The teacher can be clearly conscious of the goals of education, which otherwise are easily hidden.
- If a lot of these models are accumulated, teachers can refer to the true nature of the instruction (the goals of education) because the superficial information, which is about the type of the media and the learner's activities, does not confound them.

A proposed instructional model does not contain information about the instructional strategy. But, by accumulating both this instructional model and the lesson plan, the teachers can refer to the instructional strategy which is distinguished from the goals of education. So, we think that this approach can promote the joint ownership and reclamation of the instructional model.

Development of a system that supports teachers in the instructional design process

Description of three relations between concepts

First, we will describe the three relations between concepts behind the ontologies. For building the system that supports teachers in the instructional design process, it is necessary to describe the following three relations between the above concepts:

- The relation between each unit of information and educational goals stipulated by the Japanese Ministry of Education.

- The relation between each educational goal and educational situation required to attain it.
- The relation of educational goals to improve the effects on education by combining them.

In this paper, we do not describe in detail the contents of these relations, because their descriptions are not yet complete. Nonetheless, we will mention parts when explaining the function of our system in the next section.

The outline of the support system for teachers in the instructional design process

The functions of the support system which we have built in are as follows.

- The system shows the ontology of the IT education to teachers simply.
- The system checks whether or not necessary minimum goals of education in a unit are prepared in the instructional model that a teacher has designed.
- The system checks whether or not an instructional model, established by a teacher, satisfies a requirement to meet the educational goals.
- After a teacher makes an instructional model, the system shows other related educational goals that can be prepared.
- The instructional model designed by a teacher is stored in a server, and is keyword-searchable by other teachers.

The first function can be realized by introducing ontology to the public through Web pages detailing each concept. In these pages, each tree expresses is-a relation of goals of IT education with layered structure. Each node of this tree shows an educational goal of IT education. A teacher can get in detail information of each educational goal by clicking on each node. The second function can be realized by describing relations between the goals of education being pursued with each unit, and each concept of the ontology of IT education. This relation means the relation shown first in the previous section. The third function can be realized by describing restrictions in the instructional model to attain each concept of the ontology of IT education. This relation means the relation shown second in the previous section. The fourth function can be realized by describing relations between each concept and between each concept and each learner's activity related to each concept. This relation means the relation shown in the third one of the former section. The last function can be realized by the development of the data base software on the Web server and the Web application by the script language.

Summary

In this paper, we proposed a model of instructional design process that has been adapted to the features of the subject "Information". Then, we presented two ontologies which provide the necessary concepts to describe the instructional model of IT education based on the instructional design process. We explained that designing the instructional model based on these ontologies has some advantages. Furthermore, we showed the outline of the prototype system for supporting an instructional design process with the above two ontologies.

In future work, we intend to build this system completely and provide it for teachers of IT education. Then, we want to evaluate and improve the system by analyzing the opinions of the teachers.

References

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