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ITS Promoting Realization of Misguided Self-confidence in One's Own Comprehension

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Abstract: Most of the proposed intelligent tutoring systems (ITSs) intend for learners to cultivate a better understanding of what is written explicitly in texts regarding a target learning domain. However, these ITSs do not consider the improvement of learners' awareness of their own understanding state. To solve this problem, we develop a method for building a learner model that captures learners' misguided self-confidence in their own comprehension. More specifically, we set up a situation that allowed learners to proceed with presentation design activity using semantics-aware presentation materials (slides and terms of learning goals). In this situation, the materials have asymmetric structures between information that learners can recognize explicitly and computers can process. Based on these characteristics, our learner model allows ITS to capture what learners should set as learning goals, even if the contents are not described explicitly in the texts.

Keywords: Learner model, knowledge representation, presentation design tasks

1. Introduction

In higher education, the paradigm of learning should be transformed to orient with a structural understanding that comes from learning not only explicitly described knowledge but also tacit ones, such as the reason for the birth of a particular technology and its associated problems (Colthorpe et al., 2018). However, if teachers teach learning strategies without any concrete learning context, it is difficult for learners to ground such abstract concepts of strategies with their practical learning context such as Semantic Web (SW) (Bransford, 1999). In other words, a top-down instruction approach makes learners difficult to adapt these strategies to their learning contexts as an embodiment of learning goals that indicate their own evaluation criteria for learning achievement. Therefore, it is necessary to implement a bottom-up approach which grasps differences of criteria what they recognize they have already 'understood' particular concepts between a learner and others, and that encourages learners to evaluate their own criteria.

Many studies about intelligent tutoring systems (ITSs) propose strategies and systems that provide learners adaptive interventions for learning domains in which the knowledge, that should be understood, is defined clearly. The systems diagnose what knowledge the learners do not understand; therefore, there is a high degree of agreement about learning target domains (i.e., what should be understood) between the system and learners. Learning support methods which visualizes the learners' own state of understanding, and which gives and make learners assemble components of the domain knowledge that should be understood, are typical types of this kind of system (Hirashima et al., 2015; Woolf, 2010).

In this study, we address the research question *how to develop ITS that captures the learner's state that learners think they have already understood even though others believe the learner does not understand yet, which we called 'misguided self-confidence in their own comprehension,' and how to encourage the learners to realize this state*. To address the question, we propose (1) a task design which makes learners aware of learning goals that correspond with contents learners should understand, and (2) a system to intervene with the learners' misguided self-confidence in their own comprehension.

2. Learning Task Design and System Architecture

2.1 Learning Task: Presentation Design Activity

In this study, we designed a learning task named Presentation Design Activities (PDA). For this task, we prepared slides (shown in Fig. 1(A-iii)) and a list of words that represent learning goals, namely ToLGs: Terms of Learning Goals (Fig. 1(A-i)) as presentation materials. ToLGs are concepts that express intentions of the presentation design, such as ‘make others understand the technical limitations of SW’ and ‘make others understand the differences between URI and URL.’ Learners are provided these presentation materials and required to select and sequence these prepared materials to represent what they think it is necessary to insert into the presentation. Hereby, they require to consider what they should make others understand to achieve the final goal of the presentation, such as answering the question, ‘what is SW?’ Learners then use the ToLGs, such as *‘make others understand that URI is a mechanism that gives unique identifiers to concepts and objects’* and *‘make others understand that URL is a mechanism that gives unique identifiers to places on the Internet,’* to embody in stages the achievement goals that they have set for each slide as pyramidal structure (Fig. 1(B)). This hierarchy should be structured to satisfy the following two points. First, the attached learning goals should be consistent with contents which are described in the relevant slide. Second, contents that is implicit should also be included in the learning goals.

The system captures these two states of a target learner and generates adaptive feedbacks. Based on this task, learners are encouraged to externalize and reflect on their own learning processes and notice the insufficiency of the rigor of their criteria of learning goals.

2.2 Learner Modeling and Feedback Generation

The system generates some feedback based on two modules. One is a module that captures whether the learners try to understand the content not only explicitly described contents but also implicit ones on each slide as a learner model (Learner modeler). Another is a module that generates some feedbacks based on the learner model (Feedback generator). The learner modeler processes learner models by comparing to knowledge sets that should be explained on each slide (Slide-K in Fig. 1) and knowledge sets corresponding with ToLGs which are assigned by learners to the slide on the pyramidal structure of presentation design (ToLG-K in Fig. 1). Then, the modeler calculates two lists as learner model. One is the OK list, which the learner thinks that should be explained from the intersection set between these knowledge sets. Another is the NG list, which the learner does not think from the difference set. Moreover, each list are divided into 2 lists based on consisted knowledge types explicit and implicit; therefore, the learner models is represented as a four type lists consisting of knowledge type ([explicit]-[implicit]) and the learner’s states ([OK (trying to explain)]–[NG (not trying to explain)]).

The system capture what concepts the learner remains unaware of the need to understand and what they should reflect on their criteria for learning achievement based on this learner model.

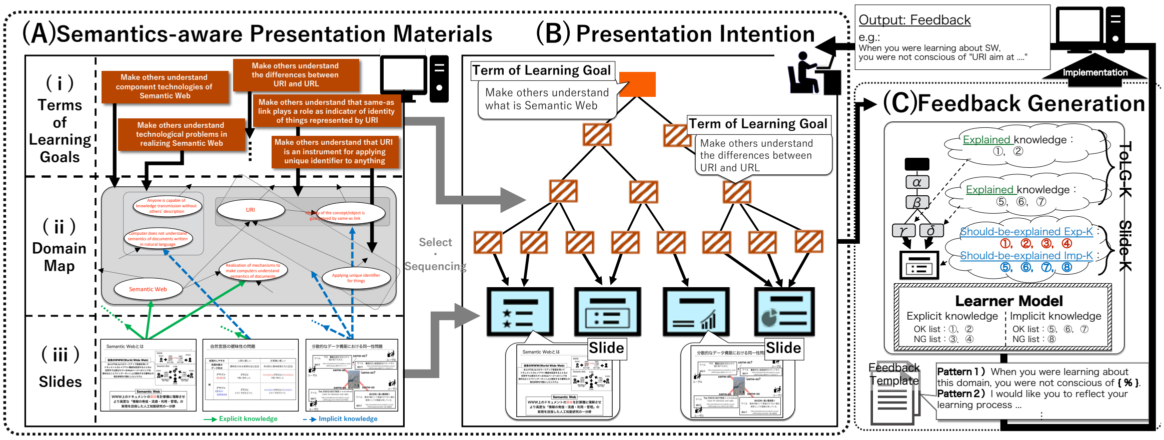

Figure 1. Presentation Design Using Semantics-aware Materials.

Table 1
Examples of Generated Feedback

Content should be explained on the slide	Generated Feedback
Difficulties in balancing distributed semantic data development and consensus building on metadata definitions, and concrete examples	***(1) To realize distributed and cooperative agents, it is necessary to specify computer-interpretable metadata, set up a common language among agents, and metadata of problem-solving procedures.*** You probably did not consciously try to understand this content explicitly written on the slides and ***(2) The realization of situational cooperative problem solving requires that different agents be able to exchange problem-solving situations with each other.*** ***(3) To deal with problems where problem-solving procedures are not programmed, a mechanism is needed to be able to read and use data from the problem-solving procedures.*** You probably did not consciously try to understand this content that is not written on the slides.

3. Pilot Study

We used the system in a learning context of Semantic Web (SW) to confirm the feasibility of what the system can be implemented in actual educational scenarios and generate feedbacks that contribute to realizing their misguided self-confidence in their comprehension. In this pilot study, we give learners a question, *'What is SW, and what are the technical problems in its implementation?'* as an achievement goal of the learning. Furthermore, we prepared ten slides and 52 ToLGs. The test subjects are five undergraduate and three graduate students. They are majoring in informatics and had not been learned SW but they had acquired essential knowledge and skills which are necessary for understanding contents. We made them use the system and analyzed the generated feedbacks.

Table 1 shows an example of generated feedback. This example shows feedback to a learner on a slide, which describes identity problems in distributed data construction. More specifically, it is stated that *"it is difficult to build consensus on some metadata among persons when some metadata are developed in a distributed manner as a SW technology"* in the slide. Then, this feedback points out that the learner did not understand both written explicit content (1) and implicit ones (2), (3). This example shows that the system generated intended feedback for giving an opportunity to promote realization of the learner's misguided self-confidence in their own comprehension about (1) to (3) with appropriate natural language subjunctive clauses, and an appropriate diagnosis that captures what the learners should be aware of as learning goals. We have confirmed that all feedbacks demonstrated appropriate sentences same as this feedback, and the system worked without any problems in practical use.

4. Conclusion

In this study, we developed an intelligent tutoring system for promoting the realization of misguided self-confidence in learners' own comprehension. Our system has a function that capture whether the learners try to set learning goals not only explicitly described but also implicitly expressed in texts, and the system also has a function that generating feedbacks for promoting realization of insufficiency of their criteria of learning goals based on presentation design activity. As future tasks, we plan to analyze whether the use of this system actually enhance to refine their recognition of self-confidence in their comprehension and to clarify the value from not only viewpoints of system architecture but also the viewpoints of educational theory.

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