Design of Intelligent Tutoring System for Collaborative Problem Based Learning

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ABSTRACT

Intelligent Tutoring System (ITS) for collaborative learning is a tutoring system that focuses on the ability of learners in collaborative problem solving, which based on learners’ knowledge and expert’s guidelines. Problem-based solving technique is used to stimulate learners to effectively analyze and use their accumulated knowledge and experiences in solving a given problem. Brainstorming is required for each step of problem-solving process and proposed solutions, resulted from collaborative work, are automatically verified to ensure correct direction or solution. This paper presents a design of an ITS for collaborative problem-based learning that used Torrance’s six-step problem-solving processes and ONION ontology mapping to verify proposed outcomes from brainstorming processes.

Keywords
Intelligent Tutoring System, Collaborative Problem Solving, Ontology Mapping, Compare Discussion, ONION.

1) INTRODUCTION

Intelligent Tutoring System is an evolution of Computer Aided Instruction (CAI), which applied an artificial intelligence technique, such as expert system, to a learning system. An ITS is a learning system that is capable to analyze learners knowledge from their performances on exercises or tests so that the system can provide appropriate learning contents to individual learner (Wittaya, 2007). An ITS as proposed by (Chitaya, et.al 2007) comprises of six components Student Module, Domain Module, Expert Module, Pedagogical Agent, Mentor Agent and User Interface. The Student Module is the component that stores all data about a learner to be used in analyzing and monitoring each individual performance and knowledge. In this module there is also a sub-component, Diagnostic Module, to perform analyzing and comparing proposed outcomes, resulted from collaborative work, with expert’s solution guideline to ensure correctness. If the proposed outcomes cannot be compromised with the expert solution guideline then another round of brainstorming or further study would be required, otherwise proceed to the next step of problem-solving process. The Domain Module is the component that stores all learning contents in form of learning objects along with metadata. The Expert Module is the component that stores problem-solving rules for both teachers and learners. The Pedagogical Agent is a software agent that automatically acquires information from the student module and expert module in order to present appropriate format or style to each individual learner. The Mentor Agent acts as the coordinator for the ITS system. It is a software agent that automatically sends and stores data for related components, e.g. detecting and sending learners’ proposed outcomes, resulted from collaborative work, to the Diagnostic Module for verification. The Interface Module is the component that controls communication among learners, teachers, and the system, including recording learners’ behaviors and sending them to the Student Module.
2) COLLABORATIVE PROBLEM SOLVING

Collaborative Problem Solving is an effective stimulator that helps learners in analyzing and using their cumulative knowledge in problem-based learning. Most problems are ill-structure problems, which have many flexible solutions. Learners need to regularly improve their skills in order to cope with this type of problems.

An approach for collaborative problem solving, as proposed by Paul E. Torrance (Torrance, 1974) is depicted in figure 1. There are six steps of problem solving processes:

Step 1 is the process of problem identification. Learners brainstorm to identify clear causes and effects or events of a given problem.

Step 2 is the process of identifying the underline problem to select only one important problem from the brainstorming activity in step 1.

Step 3 is the process of brainstorming to propose potential solutions for the selected problem (in step 2), which should be at least 10 alternatives.

Step 4 is the process of developing criteria for evaluating proposed solutions, which consists of at least five criteria for selecting the best suitable potential from 10 alternatives defined in step 3.

Step 5 is the process of evaluation of all solution to determine the best one by applying rules and criteria defined in step 4.

Step 6 is the final step which is the process of elaborating the best solution (the highest scored solution) and developing an action plan. The presentation includes the details of what, where, when, and how to address the given problem.

The process of problem identification (step 1) and the process of evaluation of all solution (step 5) require an appropriate verification technique. ONION (Mitra, P.et.al, 2007) is an ontology mapping that may be a sound approach for systematic verification.

3) ONTOLOGY MAPPING

Ontologies are knowledge bodies that provide a formal representation of a shared conceptualization of a particular domain. They are widely used in the semantic web. Recently ontologies have become increasingly common on World Wide Web where they provide semantics of annotation in web pages. The distributed nature of ontology development has led to a large number of different ontologies covering the same or overlapping domains. Therefore in order for two parties to understand each other, they should use the same formal representation of the shared conceptualization, i.e. the same ontology.

Ontology mapping is the process whereby two ontologies are semantically related at conceptual level, and the source ontology instance is transformed into the target ontology entities according to those semantic relations. With successful mapping, both ontologies are conceptually considered having the same semantic. One word then has the same somatic as other words, for example the word “HotelBooking” has the same semantic as “BookingRoom” and “ReserveRoom” (Teerayuth and Somjit, 2005).
ONION (Onion compositON) is an ontology mapping technique that can be appropriately used for verification of learners’ proposed solution (Fig. 2). This technique considers a pair of concepts whether they similar or dissimilar in semantic. The similarity values are computed for both concepts. The pair of concepts are dissimilar if the computed value is zero, otherwise the pairs is some degree of similarity. The process of verification is considered by comparing the semantic of learners’ solution and those of the expert’s solutions. If they are similar the word has value 1, otherwise the word has value 0. The probability of being the right solution (P) is also investigated. If P is less that 0.5 then the proposed solution was rejected. If P is greater than or equal to 0.75 then the solution in that process is accepted and advance to the next problem solving process. If P is between 0.5 and 0.75 then there options whether to retry on proposing a new solution or suspended for further study or quit this problem and work on the easier one.

A problem for non-English language is the difficulty in identifying a word in the solution. Thai language, for example, does not use a space to separate words and does not use a period to indicate the end of a sentence. There for it is rather difficult to identify a word in Thai language. However, there is a tool, developed by Thai research, called KU Wordcut as depicted in Fig. 3 that can identify words from a document (Asanee et. al. 2007). By using this tool, verification according to ONION technique is possible for working with Thai language.

Figure 3: KU Wordcut that is used for extracting word from Thai document

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4) MODEL ONION AND ALGORITHM

According to the ONION process, the proposed solution from learners’ brain storming will be input of the verification process. The system then compare and evaluate words from the proposed solution with those of the expert’ solution for concept similarity. The output indicates whether the proposed solution is correct or at least acceptable toward the right direction.
Figure 4: ONION concept for collaborative problem solving

Figure 5: Algorithm for a collaborative problem solving based on Terrance’s theory and ONION concept
Figure 5 illustrates an algorithm for a collaborative problem solving, which shows Torrance’s six steps of problem solving and interaction of some steps with the database to verify the brainstorming outcomes based on ONION verification concept.

5) Conclusions

This learning model uses problem-based as a technique to stimulate learners’ interests in working together to solve a given problem. The outcomes in each step, along the learning process, are used to test the ability of learners whether they can analyze and address a given problem properly and in the right direction. The future work is to investigate a program, Protégé, and test how efficient it is to managing ontology in the database. In addition to that, a proof of concept will be illustrated for the process of problem identification (step1) and the process of evaluating all solutions to determine the best one (step 5).

REFERENCES


