Pre-assessment and Learning Recommendation Mechanism for a Multi-agent System

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Abstract—Diagnostic assessment is a vital and effective strategy in any teaching-learning process such that it provides a pre-learning assessment of the learners state of knowing with regard to a given knowledge concept. Current intelligent learning systems still do not integrate effective techniques for evaluating prior knowledge that can be used effectively to diagnose gaps that will inhibit future learning and for making recommendations for learning and tutoring to fill them. In this paper, we present a mechanism for pre-assessment of previous learning upon which the recommendation for a new or appropriate learning level is based. Our approach is based on message passing procedure between agents in a multi-agent system. We have tested the pre-assessment technique with a prototype based on the Jason AgentSpeak language, and using learning materials from a structured query language (SQL) revision module.

Keywords: agents, pre-assessment, learning, tutoring, ITS, SQL, multi-agent systems, Jason AgentSpeak

I. INTRODUCTION

At the onset of any learning activity, an essential precursor is to ask students to explore their personal beliefs, attitudes, past experiences, and current understandings. How any individual will interact with a new learning situation is to a large extent shaped by what is already known or experienced. When teachers give students the opportunity to explore their prior knowledge and beliefs, and then thoughtfully look and listen at what is revealed; they are gathering information for responsive instruction. This style of teaching intentionally connects what students already know with the desired outcomes. Regardless of the method used the important thing is that gaps in understanding and misconceptions are revealed [2]. As the tutor in a face-to-face classroom context may perform a pre-learning or diagnostic assessment concerning a particular knowledge concept before teaching a higher level concept, so should intelligent tutoring systems (ITS) be modelled to assist a learner. This paper presents the analysis and design of a mechanism in which a proposed Agent Based Pre-Assessment and Tutoring System (ABPATS) is modelled for pre-assessment of previous learning before the take-off of new learning. The aim is for ABPATS to identify the gaps: zone of proximal development-ZPD [4] in knowledge between what is already known by a learner and his desired learning, and identify materials that would help in filling the gap.

Pre-assessment is the inquiry into relevant pre-existing knowledge at the start of a learning process to identify whether a learner has the necessary background to enable them to move forward with the new material that they wish to learn. Pre-assessment creates a synergy between previous learning and the start of new learning, and prompts any related prior learning. This is quite different from other forms of assessment: Formative - which occurs during an ongoing learning or summative - which comes at the end of learning for possible scoring and grading. Pre-assessment identifies the learners’ current understanding and where to start new learning. Pre-assessment therefore leads to a better formative assessment leading to the best summative evaluation (Fig 1).

A. Related Work

There are several ITSs but a few considers prior learning during learning activity. For example, there is the Algebra Tutor PAT [3] that uses prior knowledge of maths to map problem situations together, and SmartTutor [1] which adapts prerequisite profile for training and mastery of a concept. But none of these uses pre-assessment as a necessary strategy for determining readiness for higher level concept-learning. Thus, in the process of pre-assessment, ABPATS offers: 1) Autonomy to learners to decide what concept to learn in a given learning content; 2) Pre-assess prerequisite concept to be certain of what the learner knows or does not know before proceeding on the learning ladder; and 3) recommend the appropriate learning material via web URL. This approach that could considerably be integrated into existing ITSs is being proposed on an agent platform because of the ability of agents to execute own goals, individual responsibility, and communicate intentions.
II. DESIGN PHASE

The ABPATS design was based on the following two scenarios:

A. Scenario

A learner has received his course synopsis for the semester in the order of simple to complex. On the ABPATS system, the learner enters a concept, his next learning target. ABPATS needs to ensure the learner has an adequate understanding of the prerequisite concept to the desired concept entered before the commencement of learning. The GUI agent takes the learners input via percept, and passed it to the learning support agent that has the rules for pre-assessment and recommendation for tutoring. The learner is pre-assessed, decision is taking, and the learner is informed: and the universal resource locator (URL) of the learning materials are recommended based on either a pass or a fail pre-assessment.

B. SQL Learning Structure

The learning structure for this design is Structured Query Language (SQL) upon which the prerequisite quizzes and learning materials were drawn. The SQL content covers four query manipulation concepts, namely: SELECT, INSERT, DELETE and UPDATE statements. Following a pedagogical process, these query concepts are presented in a top-down hierarchy, where any immediate-lower concept is a prerequisite to its next higher concept (Fig. 2).

C. Establishing Goals for Agents

Given that a desired concept is \( T_n \) and its prerequisite is \( T_{n-1} \), the performative actions for pre-assessment after \( T_n \) is entered by the learner is represented as:

- Precondition: A quiz of the \( T_{n-1} \) prerequisite concept has been asked.
- Postcondition: Learner provided an answer \( A_n \).
- Completion: The learner is pre-assessed.

For the systematic operation of the pre-assessment and tutoring system, a mechanism of operation was devised based on decision-making strategy and recommendation for learning (Fig. 3). The work flow of the mechanism is illustrated with four concepts represented as A, B, C, and D; where A is the least concept and D is the highest in hierarchy.

III. IMPLEMENTATION PHASE

Using Jason AgentSpeak language, we implemented the pre-assessment mechanism and tested the pre-assessment techniques by creating five agents. Given their various goals, agents collaborated and executed their plans following the scenario and SQL learning structures. For example, when a user (the authors) entered the DELETE concept, he was pre-assessed on the INSERT concept. When he got the INSERT pre-assessment right, he was tutored in his desired DELETE concept with the recommended URL. But with a wrong answer, he was further pre-assessed on SELECT concept to ensure further that there is no preceding learning gaps.

IV. CONCLUSION AND FURTHER WORK

This paper has described the preliminary work on the concept of pre-assessment and its significance before the start of new learning. And also presented a strategy for identifying gaps in learning through a pre-assessment and tutoring mechanism. Using Jason we tested the mechanism with SQL concepts and query statements to identify gaps and filling them before the start of a higher concept. In this approach, users decides on what to learn within a given learning content and ABPATS ensures nothing inhibits the adequate take-off of a learning target. An approach that can be integrated into existing adaptive tutoring systems.

Future work is to create a JDBCPersistentBB in the MAS that would connect ABPATS to a relational database engine. With this connection, we intend that every SQL-query statements that are submitted as answers to the pre-assessment quizzes will query result-sets from the database while some design principles such as the usability of ABPATS is being x-rayed.

REFERENCES