Enhancing Conceptual Change through Cognitive Tools: An Animated Pedagogical Agent Approach

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Abstract

This article discusses the integration of animated pedagogical agent into the development of cognitive tools based upon Scientific Inquiry Model for invoking learners’ cognitive conflict and fostering conceptual change. In this study, animated pedagogical agent acts as a catalyst while coaching the learner who interacts individually carrying out the hypothesize-observe-experiment activities. Study shows that through cognitive apprenticeship, the animated pedagogical agent is able to interact actively with the learners by allowing them to make their own sense of imposed ideas, extracting meaningful patterns and integrating new input with their prior belief and ideas in order to foster the conceptual change process.

1: Introduction

Recent studies reviewed that simply presenting learners with a Newtonian view of the world, however perspicuous and sequenced, is usually insufficient for getting them to change their thinking about how the world behaves [1]. A more effective approach is one that encourages students to question their beliefs, to catch themselves in explanatory incoherence, and finally engaging them in the process of changing alternative beliefs. In order to create the disequilibrations in their thinking [2], in this study, the integration of scientific inquiry model and animated pedagogical agent that acts as cognitive tools is identify as one of the promising methods.

1.1: Conceptual Change and Animated Pedagogical Agent

Animated pedagogical agent plays a vital role as cognitive tools in facilitating the learning process based on Scientific Inquiry Model. Through agent, environment where the learner has to think harder and in depth about the scenario given, using the agent as a natural cognitive extension. In this study, learner is viewed as an active participant in constructing his or her own knowledge with the assistance from agent rather than just merely being a passive process of receiving information or acquiring isolated pieces of knowledge. Learning involves altering one’s existing conceptual framework in the light of new experience. Conceptual change is thus considered to be a process of progressively reconstructing mental representations [2] and has been described as a process of learning science in a meaningful way that requires the learner to realign, reorganized, replace existing misconceptions in order to accommodate new ideas [3][4].

2: Scientific Inquiry Model

The figure below depicts the Scientific Inquiry Model implemented for the development of prototype software. Learners will be asked to identify the variables and followed by stating the relationships between variables through graph. Hypotheses are then formed in order to predict the appropriate relationships between the different types of variables. It is from the computer simulations and interaction with agent that students will try to validate the hypotheses they have formed. The replication of experiment carried out in the real world is presented. This study indicated that learners going through Scientific Inquiry Model are eventually trained to be able to form hypotheses, validating hypotheses, identifying correct and suitable variables and subsequently generalizing a particular concept.
3: Fostering Conceptual Change through Animated Pedagogical Agent

The discrepant event in conceptual change instructional strategy that conflicts with learner’s existing conceptions has been kept in the agent’s knowledge base. Together with computer simulations embedded in Scientific Inquiry Model, Merlin is capable of fostering learners’ conceptual change in terms of:

(i) Confronting learners’ alternative conceptions by creating cognitive conflict through dissatisfaction with their prior knowledge.
(ii) Maximizing the intelligibility, plausibility and ability to understand the new conception.
(iii) Reconceptualization of new asserted conception that appear to be fruitful.

3.1: Conceptual Change through Scientific Inquiry Model

In this study, the conceptual change can be described as a process of change from the learner’s prior conceptions to some intermediate conceptions and then to scientific conceptions which is depicted in the figure above. Considering the initial hypothesis that contains misconception formed by learners as follow:

“As the diameter of spring increase, the tempo of spring will increase.”

Initially, learners bring a set of prior conceptions (misconception) presented by “Diameter ↑ ⇒ Tempo ↓” with the belief that the number of atom increases as the diameter of spring increases. The increase in number of atom will then increase the force of gravity and subsequently decrease the tempo of mass on spring. The computer simulations in “Hypotheses Simulation” serve as the primary discrepant event in conceptual change instructional strategy that conflicts with learners’ existing conceptions. Learners are allowed to freely explore, experience, and validating their initial beliefs stated in the hypotheses. This is achieved as it allows learners to manipulate parameters and visualizing immediately the consequences of their “drag and drop” actions. The learners will then further navigate to “Experiment Simulation” to further validate the relationship between the diameter of spring and the tempo of mass on spring. The difference between the computer simulation shown in “Hypotheses Simulation” and “Experiment Simulation” has further enhanced the cognitive conflict. With the existence of Merlin, learners are coached interpret and reflect on relationships between diameter of spring and tempo, reformulate and retesting hypotheses, as well as reconcile and conceptual conflict between their ideas and observations in microworld. The learners are then further investigate the relationship between the diameter of spring and the constant $k$. After recursively investigate and analyze the real experiment simulation and manipulating the parameters in “Formula Manipulation”. Learners are then finally successful in relating the constant $k$ with diameter of spring.

4: Conclusion

This study provides an insight into the integration of animated pedagogical agent into Scientific Inquiry Model that serves as a paradigm shift to the needs of educational technologies especially in terms of creating conceptual conflict and fostering conceptual change. Animated pedagogical agent together with the computer simulations has not only effectively altered learners’ misconceptions, but able to simulate the cause-and-effect of science experiments and thus enhancing conceptual change as well as the development of high-order cognitive skills and scientific process skills.

5: Reference