

Executive Summary of

Learning by Teaching: A New Agent Paradigm for Educational Software

Mary Takle

University of Washington, Bothell

Betty's Brain is a software program designed to be used by students as a learning aid in order to prepare them for self-directed future learning. The software employs an interaction between the student learner and a teachable agent, Betty, and her mentor, Mr. Davis. The student teaches Betty through the use of a concept map. Students study online materials to learn about a river ecosystem, construct a concept map and then query Betty about her understanding of the river ecosystem. Betty responds to the query with both an answer and an explanation, which illustrates the process Betty utilized to attain her answer from the concept map. Once the student has revised the model and is satisfied that Betty understands the material, he requests that the mentor agent quiz Betty. The quiz has been written by the teacher; the mentor agent works from a master concept map that is preprogrammed into the software. Both Betty and the mentor give feedback to the student using voice responses. Mr. Davis' responses inform the students of any errors they have in their concept map and encourage the students to research and refine their concept map.

The ultimate goal of Betty's Brain is for the student to gain the ability to learn, not just acquire new knowledge. The three effective interactions that the authors incorporated in Betty's Brain were "developing structured networks of knowledge," assist the students with "taking responsibility for making decisions about learning," and encourage the student in the "development of reflection" on the learning (Biswas, Leelawong, Schwatz, Vye, & University, 2005). The developers chose to assimilate these interactions into Betty's Brain through the use of learning by teaching. The use of a concept map compels the students to organize the information and illustrate the relationships, enabling them to develop connections between concepts. The interaction that occurs between Betty and the student during the query process is designed to direct the student into creating a complete model with accurate connections and facilitate the learning progression. The quiz ingredient of Betty's Brain permits reflection on Betty's learning and allows students to continue to revise their model based on the outcome of Betty's

performance on the quiz. The student, as the teacher, must accept the responsibility for Betty's learning and adjust his teaching accordingly.

Three different versions of Betty's Brain were used in an experiment with a fifth grade class. One version was the intelligent tutoring system (ITS) where the student was taught only by Mr. Davis. He gave instructions and direct feedback when the student answered quiz questions incorrectly. In the second version, the learning by teaching (LBT) version, students would teach and query Betty, Mr. Davis would in turn quiz Betty, and Betty would receive feedback about how well she performed on the quiz. The third version, the self-regulated learning (SRL) system, was an improved system over the LBT. It included all the elements of the LBT with an enhanced Betty and Mr. Davis. Betty's additional feature was the ability to interact with the student during the concept map creation. Betty could observe the student and interject with her understanding of the concept map. Mr. Davis' improvement was that he no longer just gave an answer when the quiz was incorrect, but instead helped students via directing Betty on what she needed to study further in order to get the question correct as well as giving tips to students on their teaching and problem solving skills.

Test results showed that all three versions were successful in increasing students' immediate knowledge of the subject, as demonstrated on the memory tests. However, only the third model with the self-regulated learning increased a student's ability to learn new material when given a similar project with a different topic two months later. The self-regulated model did appear to achieve the goal of assisting a student in learning how to learn.

The developers have purposefully created this software to enable the student to take control of his learning by helping to model an effective way to learn by teaching another. There are several advantages to having a teachable agent (TA) play the role of student. First, it requires the students to take responsibility for what they will teach to Betty and to present it in a coherent way. Second, the student, as teacher, gains the advantage of seeing exactly how Betty learns so they can adjust their teaching

accordingly. Watching Betty learn benefits the student in that they can observe a logical way to learn and hopefully apply a similar process on their own at some point in the future. Another benefit to Betty as the TA, is that Betty is the one who gets the problems wrong, not the student. The indirect nature of the software can remove some of the fear of getting the wrong answer that students sometimes bring with them into a learning situation.

The additional features in the LBT model strengthened the software significantly in two ways. By removing the ability for the students to quickly get the “right” answer from Mr. Davis and replacing it with suggestions to Betty as to how she might learn better, the student is forced to continue to think about the problem and arrive at a solution. As long as this is something the student does not become frustrated with, this can be a very effective. Learning is still occurring when the student returns to the data to try to find the material to help Betty learn better. The developers even considered the frustration factor that students can sometimes encounter and made sure that Mr. Davis would be able to eventually direct them to the right answer.

The software developers intentionally created every aspect of the software to assist the student with learning. Their careful attention to each element of the learning process and continued improvement of the software generate a potentially successful learning tool that can be integrated into a classroom.

References

Biswas, G., Leelawong, K., Schwatz, D., Vye, N., & University, T. T. (2005). Learning By Teaching: A New Paradigm for Educational Software. *Applied Artificial Intelligence, 19*, 363-392.