Software Tutors for Scaffolding on Planet Oit

Brian M. Slator1, Lisa M. Daniels2, Bernhardt Saini-Eidukat3, Donald P. Schwert3, Otto Borchert1, Guy Hokanson1, Richard T. Beckwith4

Departments of Computer Science1, Teacher Education2, Geosciences3, North Dakota State University (NDSU), Fargo ND 58105, Intel Corporation4

Abstract

Planet Oit is a multi-user virtual environment used to teach geologic concepts and the scientific method. It is built on a structured system of modules and goals arranged so that students have freedom, but have direction as well. Intelligent software tutors explain geologic concepts, guide the players in achieving their goals, and assist them in understanding the environment. Planet Oit and its system of goals, tutors, and scaffolding are described.

1. Introduction

The NDSU Worldwide Web Instructional Committee (WWWIC) is a multi-disciplinary group composed of faculty, staff, and students from a variety of departments and colleges that studies learning in immersive virtual environments (IVE) for education.

Each project is a role-based immersive simulation intended to promote learning-by-doing. Each is spatially-oriented, exploratory, and highly interactive [4]; as well as multi-user and game-like. They employ a task model to monitor student progress and range of software agents as tutors and guides [7].

The Geology Explorer [5, 6] is a comprehensive educational media project implementing a virtual world, Planet Oit, where learners assume the role of a geologist on an expedition to explore this mythical planet. Learners participate in field-oriented expedition planning, sample collection, map building, site interpretation, and "hands on" scientific problem solving. Planet Oit is simulated on an Object Oriented Multiuser Domain, the Xerox PARC LambdaMoo [2].

The Geology Explorer consists of a framework of materials and goal-driven modules that students complete for a sense of progression. Within this context, a system of tutors and guides direct and remediate the student in a manner similar to mentors on a field course. This mentoring takes the form of hints and advice, usually delivered when students have made an error, or are in danger of doing so. These interactions, timed as they are, provide a form of scaffolding [3], as the students work to construct their own understanding of the discipline content. Because of the vast differentiation among learner readiness, individualization of the learning environment is necessary [8]. Thus, students interact with other players, students and teachers alike, and software tutors, experiencing an environment that is conducive to social constructivism [9].

2. Scaffolding

Scaffolding as a learning strategy originates from Lev Vygotsky's [9] concept of the zone of proximal development (ZPD). This is the distance between what students can do by themselves and the learning that they can be helped to achieve with competent assistance. This strategy provides individualized support based on the learner’s ZPD. Typically, a more knowledgeable “other” provides support, scaffolds, to facilitate a student’s development. These scaffolds facilitate a student’s ability to build on prior knowledge and assimilate new information. The activities provided in scaffolding instruction are just beyond what the student can do alone. The more capable other provides the scaffolds so that the student can accomplish, with assistance, the tasks they could otherwise not complete, thus helping the student through the ZPD. As the learner’s abilities increase, the scaffolding provided by the more knowledgeable other is progressively withdrawn [9].

Scaffolding is embedded in the constructivist philosophy of education – meaning essentially that students are not taught, they learn [1]. Teaching then is the act of creating experiences in which students can explore and construct their own knowledge of a given objective.

3. The Module Framework

The Geology Explorer module framework is based on a system of well-defined goals. Each module contains a sequence of sub-goals that students must complete before they can advance to more complicated topics. For example, upon entering the virtual environment for the
first time, students are given a specific exploratory goal. This goal is completely customizable by the teacher who is using the software, but is normally an identification task, since rock and mineral identification is one of the basic and important skills of geology. Students are given one particular rock or mineral, selected at random (but from a principled set, from easy to difficult), to locate and identify, but they are not required to find that particular object. In fact, in order to proceed, they must simply earn the requisite number of points, which can be obtained by either identifying the rock or mineral they have been assigned, or by identifying any rock they find on the planet's surface. This allows the students great freedom in proceeding how they wish in the virtual world, investigating what they wish to investigate, exploring as they choose.

Students progress through a rock and mineral identification module to a more advanced interpretive mapping exercise. Other modules are under development.

4. Tutoring on Planet Oit

On Planet Oit, tutoring is accomplished through unobtrusive but proactive software agents. These are diagnostic tutoring agents that provide assistance to students in the course of accomplishing their goals. These tutors work from knowledge of the rocks and minerals found on the planet, the student’s history, and knowledge of the experiments needed to confirm or deny the identity of a substance. These tutors include an Exploration Tutor for determining if a student has overlooked an important goal, an Equipment Tutor to insure students have the necessary instruments, a Geology Tutor for help with identification and interpretation tasks, various Guides for context-relevant help, and a cast of several other minor players.

One of these, the Pop Quiz Tutor, quizzes students on their factual knowledge of their present/current goal. It appears before players at random times in random places, asking a question about their present goal. For example, asking what color their present goal is if the player is searching for Graphite, the question might be “For ten points, what is the hardness value of Graphite. You have 30 seconds to respond.” This allows the students yet another way to get points to complete the module, and also tests to see if they understand what are aware of the properties of the goal they are searching for.

The Map Tutor provides feedback for a student creating a geologic map. To succeed, the student must first identify each outcrop in the module area. The map tutor informs the student of their progress. When they reach the map production goal, this tutor tells the player where they have problems with their map, what areas they should focus on, and if they have missed any outcrops important to a correct geologic map solution.

None of the tutors is highly sophisticated on its own. The strategy has been to implement a large number of specialized tutors that together form an array of scaffolding interventions, each programmed to monitor student progress and intervene at the moment they are needed.

5. Conclusion

The instructional tutoring agents on Planet Oit implement a scaffolding strategy. The tutors are there to provide help if needed, remediate on student actions and to point students in the right direction. As a student progresses through each module they are progressively given less help and more difficult tasks. It is an important component of constructivism that only prompts and guidance are given. Giving students an answer which they then can simply memorize reverts back to a behaviorist approach which is ineffective for authentic, long-term learning.

Acknowledgements

This portion of WWWIC research was supported by funding from the NSF under EIA-0086142 and the U.S. Dept of Education under FIPSE #P116B011528.

Contact: slator@cs.ndsu.edu To visit Planet Oit, go to http://oit.ndsu.edu

References