

LEARNING WITH REFLECTION: PROJECT PRAXIS

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Abstract

Classroom learning improves significantly when students participate in structured learning activities in small groups of peers. As the U.S. military moves from schoolhouse instruction to web-based distance learning, the student loses this important contact with other students. The educational value of student collaboration has led to the use of conventional groupware tools, such as chat and email, in distance learning environments. While these tools can enrich learning, they require at least two participants who are available at the same time and cannot guarantee the quality of assistance. Students in a web-based environment require high-caliber instructional support on demand. A simulated *learning companion*, acting as a peer in a distance learning environment ensures the availability of a collaborator and encourages the student to learn collaboratively, while drawing upon the advantages of distance learning. The learning companion we designed for PRAXIS encourages the student to reflect on and articulate past actions, and to discuss future intentions and their consequences.

Biographical Sketches:

Dr. Bradley A. Goodman is a Principal Scientist and Associate Department Head in the Information Management and Instructional Systems Department at the MITRE Corporation in Bedford, MA. Dr. Goodman received his B.S. degree in Mathematics from Carnegie-Mellon University and his M.S. and Ph.D. degrees in Computer Science from the University of Illinois at Champaign-Urbana. Dr. Goodman has been at MITRE since 1990. He was a Part-Time Visiting Scholar in the Department of Computer Science at Brandeis University from 1991-1996 where he conducted joint research with TERC. Dr. Goodman was a Senior Scientist in the Speech and Natural Language Department at Bolt Beranek and Newman Inc. from 1980 to 1990. He has worked in several areas of artificial intelligence, including collaborative learning systems, intelligent tutoring systems, and intelligent interfaces. Dr. Goodman has also performed research in educational technologies for K-12 education. Dr. Goodman has published over 30 technical papers in the areas of collaborative learning systems, intelligent tutoring systems, and intelligent interfaces.

Mr. Iorizzo became Chief of the Distance Learning Office at the United States Army Military Intelligence Center at Fort Huachuca, AZ, in 1998. He mentors a twenty-four-person development team in the production of distance learning products based on Constructivist learning theory delivered via Internet. He leads Praxis, an initiative for the Military Intelligence Captains Career Course, to integrate a synthetic learning agent with a virtual tactical operations center to provide the benefits of synchronous collaboration when peers are unavailable. Mr. Iorizzo served as Technical Advisor for the United States Army Armor School, Fort Knox, KY, for five years. His foundational work in instructional design and prototype development with distance learning for the Armor Captains Career Course culminated in a United States Distance Learning Association award to Fort Knox for best overall program, government category, in 1999. Mr. Iorizzo has extensive experience integrating systems for distance learning by establishing dual and shared use agreements between federal and state agencies. He has co-authored a number of papers on distance learning over the last eleven years and continues to present at training and technology conferences. Mr. Iorizzo holds a master's degree in Instructional Design, Development, and Evaluation from the School of Education at Syracuse University with a concentration in Communications.

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INTRODUCTION

Research in education has shown the importance of learners reflecting on what they have done so far and articulating it to others (Brown & Palincsar, 1989). Reflective activities, such as After Action Reviews in military exercises, encourage students to analyze their performance, contrast their actions to those of others, abstract the actions they used in similar situations, and compare their actions to those of novices and experts. Reflection enhances the learning benefit of an exercise because it gives students an opportunity to review their previous actions and decisions before proceeding, enabling them to make decisions that are more educated later. Articulation is the process of explaining to others the problem solving activities that have occurred, which in turn enhances retention. A student, for example, could be placed in a scenario where they are required to act and then explain the reasoning behind the actions taken to others. In so doing, the student builds a deeper understanding of the instructional content.

PRAXIS means action with reflection. The purpose of Project PRAXIS is to prepare Intelligence Officers to adapt to unknown situations. The domain is brigade operations with emphasis on intelligence support to the Military Decision Making Process (MDMP).

PRAXIS supports peer learning by providing an interactive web-based learning environment through the union of three key instructional components: the Virtual Tactical Operations Center (VTOC) environment (Paschetto, Jackson, Arnold, Garion, & Lorenc, 1999), a computer-based training (CBT) system, and an intelligent tutoring system with an integrated simulated Learning Companion (Goodman, Soller, Linton & Gaimari, 1998). VTOC is a collaborative environment that provides an authentic simulation of a military Tactical Operations Center (TOC) by integrating a 3-D navigation tool, 2-D map tool, 3-D terrain viewer, and a chat tool. The VTOC serves as a user interface. A soldier can

navigate through the virtual TOC to access problem-solving activities, tools, reference materials, and to reach out to others for help. The CBT provides access to core and reference lessons that are germane to a brigade intelligence officer's competencies. The core lessons are highly interactive with built-in exercises. The core lessons present students with a problem, the tools to solve the problem, and the consequences of their solution to the problem. Reference lessons are more informational in nature. The Learning Companion is an intelligent agent that plays the role of a peer in an intelligent tutoring system who asks and answers questions and offers suggestions much like a human peer would as the soldier works through exercises in the environment. A web-based, CBT hybrid approach found collaboration essential when training portions of the MDMP for company commanders (Jackson, Lorenc, & Iorizzo, 1997; Connolly & Bradley, 1997). Integrating a Learning Companion addresses collaboration as a way for the learner to elaborate on specific skills to achieve general competencies even when others are unavailable.

The Learning Companion encourages the soldier to justify decisions, consider and articulate alternative courses of action, and evaluate its sometimes misleading suggestions. The Learning Companion also provides feedback on the consequences of actions the soldier has taken and can respond to questions from the soldier. Like a real human peer, the Learning Companion is fallible and can provide a soldier with incorrect or buggy advice, pushing the soldier to carefully apply newly acquired knowledge to judge the advice. Requiring a soldier to think about past actions and explain consequences, or further evaluate proposals and future intentions through collaboration encourages a soldier to learn from mistakes, reconsider decisions, and restructure knowledge. Having another collaborator available is a trivial issue with soldiers studying in conventional schoolhouse settings; however, when instruction centers around a particular

soldier and individual time constraints, finding other collaborators for learning is more difficult. The PRAXIS Learning Companion is a solution for web-based distance learning; the Learning Companion is available at the soldier's discretion without the need to worry about the availability of other collaborators.

This paper describes the issues raised while developing a learning companion as part of an actual web-based distance learning course and the benefits gained from this union. The paper gives an overview of the applied learning theories. We delineate the issues faced by intelligent web-based instructional systems to provide effective coaching, and elaborate on the importance of reflection and articulation in learning as one component of the instructional benefits of collaborative learning. We explain the learning companion developed for PRAXIS and give a brief description of its architecture. We summarize how the PRAXIS learning companion delivers its proposed enhancements to instruction and conclude with future directions for this work.

CONSTRUCTIVIST LEARNING THEORY MEETS WEB-BASED TRAINING

Soldiers face conflicts in a rapidly changing world. These conflicts can not be fully anticipated when developing training for the classroom. Consequently, soldiers must adapt to the reality of an ill-defined battlefield by applying what they have learned and reasoning about the situation at hand, instead of relying on schoolhouse solutions. Constructivist learning advocates stress the importance of active learning by a student to construct the knowledge they will later require to solve a new and possibly unanticipated problem. It is the action of constructing the knowledge that leads to learning and the ability to apply the knowledge at a subsequent time (Mayer, 1999). Active participation alone is not sufficient to cause learning. Learners need a way to articulate and receive feedback on their thoughts in order to shape meaningful constructs that can be applied to contextual situations. Accordingly, social context plays an important role in constructivist learning.

Constructivist learning can be accomplished by a variety of techniques (Jonassen, 1999): (1) Information can be presented to a student who must then make sense out of it; (2) students can study representative cases and abstract from them (case-based) to acquire knowledge and skills; (3) project-based instruction builds on instructionally progressive cases over time that yield the foundation

the student requires; (4) problem-based learning involves self-directed learning around a curriculum. Jonassen [1999] points out the importance of providing students with ill-defined or ill-structured problems to promote in each student a sense of ownership of the problem. Problem ownership motivates students to find a solution to a problem.

Scenario-based instruction provides a powerful form of constructivist learning. A student is presented a scenario to reason about that is representative of the domain under instruction, a set of tools to manipulate the domain, and reference materials to find out more about the domain. The student is asked to perform a particular task in the context of the scenario, leading to a competency. Student access to peers and an instructor can provide important scaffolding necessary for the student to solve the problem.

Web-based instruction provides a medium to carry scenario-based instruction to a student. It reaches out to the student at a distance. Multimedia, problem-solving tools, and reference materials can be delivered over the web. The student is assigned a problem to solve in the context of a particular scenario. The scaffolding provided by peers and an instructor in a classroom situation, however, are typically missing in this instructional setting. This has led to a number of web-based synchronous tools. These tools require users to come on-line at a scheduled time.

REINFORCING THE FOUNDATION

Scenario-based instruction delivered through the web can be enhanced with access to peers and instructors by building on two other instructional techniques and supporting technologies, computer-supported collaborative learning (CSCL) and intelligent tutoring systems (ITS).

Computer-Supported Collaborative Learning

Another paradigm, that has the potential to significantly improve learning, is collaborative learning. Classroom learning improves considerably when students participate in structured learning activities with small groups of peers (Brown & Palincsar, 1989; Chi, Bassok, Lewis, Reinmann, & Glaser, 1989; Doise, Mugny, & Perret-Clermont, 1975). Peers encourage each other to reflect on what they are learning and to articulate their thinking, which enhances the learning process. The educational value of student collaboration has led to the

development of computer-supported collaborative learning tools (Lund, Baker, & Baron, 1996; McManus & Aiken, 1993). These tools enrich learning in a setting that encourages students to communicate with their peers while solving problems on-line.

Web-delivered scenario-based exercises can be enhanced through access to peers and instructors using CSCL tools such as email, chat mechanisms, and shared whiteboards. The Armor Captains' Career Course (AC3) offered at the U.S. Army Armor School, Fort Knox, KY, employs two distance learning phases, an asynchronous self-paced phase and a synchronous group-paced phase, that facilitates student and instructor feedback over the web. It employs a version of VTOC that is being enhanced for PRAXIS. Peer support can encourage students to discuss and reflect on their problem-solving activities. Instructors can be asked to comment on student actions.

Intelligent Tutoring Systems

Intelligent tutoring systems provide the kind of environment conducive to scenario-based instruction with its built-in scaffolding (Anderson, Boyle, & Yost, 1985; Brown, Burton, & Bell, 1974; Lesgold, Lojoie, Bunzo, & Eggan, 1988). They provide students with individualized instruction and coached practice in an interactive environment that fosters active learning. The tutor in an ITS behaves much like a human instructor in a one-on-one tutoring session, observing the student's problem solving actions and offering advice and guidance upon request. Although CSCL systems provide exceptional

learning environments, they do not offer students the type of individualized assistance and guidance available in an ITS, and they require at least two participants willing to learn through collaboration. A simulated *learning companion* (Chan & Baskin, 1988), acting as a peer in an intelligent tutoring environment ensures the availability of a collaborator and encourages the student to learn cooperatively, while utilizing the instructional advantages that ITSs provide. A simulated peer behaves as a partner for the student in learning and problem solving.

Learning Companions

The learning companion described in this paper enhances learning by initiating a dialogue with a student to force the student to reflect and articulate on their learning (Goodman et al., 1998). A positive side-effect of using a learning companion is that more information is available for the ITS's student model to record the student's understanding of the material. A more detailed student model can lead to better coaching and problem selection for the student. Research has shown the instructional value added by having a student work with a peer in a learning environment (e.g., Brown & Palincsar, 1989). While the tutor could be designed to play the role of a peer, it is better to differentiate these roles since a student has higher expectations for the quantity and quality of communication received from a tutor than from a peer (Fox, 1993). Moreover, learning companion and student interactions can be more tightly constrained while still achieving the desired effect of getting a student to clearly lay out their reasoning.

Table 1 illustrates the differences between a student-

Table 1. Comparison between student/tutor and student/peer dialogues

Student/Tutor Dialogue		Student/Peer Dialogue	
Student:	What do you think I should do next?	Student:	What do you think I should do next?
Tutor:	Link a threat to some evidence.	Peer:	Link a threat to some evidence. What do you think?
		Student:	I do not think that is a good idea.
		Peer:	What would you suggest?
		Student:	Choose the most applicable threat.
		Peer:	Which one do you think is most applicable?
		Student:	The enemy Air Assault Brigade is a threat.
		Peer:	Why would you choose that as the most applicable threat?
		Student:	I have found conclusive evidence supporting this threat.
		Peer:	I don't think that's a good reason. Let's ask the instructor.

tutor exchange in a standard intelligent tutoring system and a student-peer exchange in an intelligent tutoring system with a learning companion. The student asked the same question in both the student/peer dialogue and student/tutor dialogue. The answer is the same both times, but the learning experience is very different. In the student/tutor case, the tutor gave a factual response. In the student/peer case, the learning companion did more, giving the same information but inviting conversation. It also encouraged the student to explain and articulate their thinking, which exposed a misconception. The learning companion then prompted the student to justify and rethink their explanation, and suggested consulting the instructor, who would correct the misconception. It is possible to have the second kind of discussion with a tutor, but easier and more natural to have it with a peer.

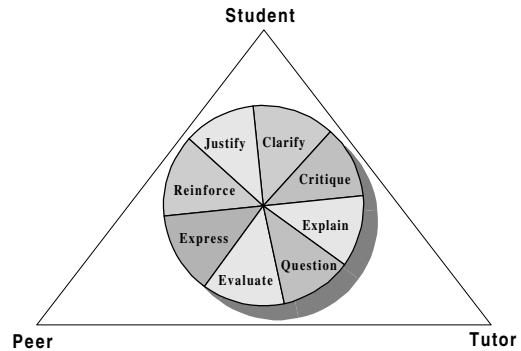
The Learning Triangle, displayed in Figure 1, illustrates the increased student communication possibilities afforded by adding a peer to the student-tutor paradigm underlying an ITS. The circle in the center of the triangle shows the interactions, which typically contribute, to a student's learning experience. The right side of the triangle denotes the communication between a student and a tutor found in many ITSs. The left side of the triangle indicates the types of interactions that may occur between a student and a peer. Interactions such as Justify, Express, Reinforce, and Clarify increase the student's understanding of the subject matter. Student-peer and student-tutor communication can use any of the interactions in the circle; the more likely interactions are shown closest to the relevant side of the triangle.

Table 2 shows the potential instructional function of each interaction type. It is meant to illustrate a portion of the pedagogical space underlying student-peer and student-tutor communication. A learning companion can initiate these types of interactions during dialogue sessions with the student. Reflection and articulation are two key pedagogical functions underlying student-peer dialogues and the ones focused on in this research. A learning companion can help a student reflect on thinking by critiquing, questioning, or evaluating particular steps. Similarly, the student and learning companion may articulate those steps through further explanation or elaboration.

The bottom side of the triangle illustrates the type of potential communication between the peer and the tutor. In PRAXIS the tutor and the peer do not

communicate directly but instead share information about the student through the student model. The tutor sees changes in the student model from student-peer interactions and reacts accordingly.

Figure 1. Types of Dialogue Interaction



PRAXIS will require a student, given a scenario to explore, to evaluate (potential) threats, develop intelligence requirements, and analyze likely actions of enemy and friendly forces. The student will produce (1) overlays for a map of the situation to highlight threats, (2) overlays that show likely movement of enemy and friendly forces, (3) a prioritized intelligence requirements list, and (4) evidence to support decisions. The student can use an argument table to link evidence derived from reported message traffic, the map situation, and information from headquarters, to threats delineated on the map to indicate to PRAXIS support for particular hypothesized outcomes.

Table 2. Potential Functions

Interaction	Pedagogical Value
Clarify	Articulation
Critique	Reflection
Explain	Articulation
Question	Reflection
Evaluate	Reflection
Express	Articulation
Reinforce	Articulation
Justify	Articulation

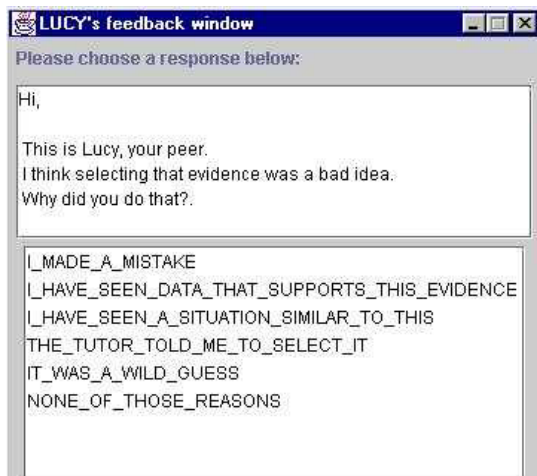
CAPTAIN LUCY, THE PRAXIS LEARNING COMPANION

The PRAXIS Learning Companion, CPT LuCy, is an interactive synthetic peer who answers student's questions and offers suggestions much like a human peer. CPT LuCy encourages the student to justify

decisions, consider and articulate alternative courses of action, and evaluate CPT LuCy's sometimes misleading suggestions. One primary difference between CPT LuCy and human peers, however, is that CPT LuCy is always available at the student's discretion; the student need not worry about the availability of other student collaborators. Unlike conventional classroom settings, finding collaborators for learning in a web based instructional environment is difficult because the experience is largely autonomous.

This section describes CPT LuCy's role in the student's overall learning experience. The rationale behind the design is dependent on this role. Since the tutor in an ITS also plays a major part in shaping the student's learning experience, this section discusses some differences between these two perspectives. CPT LuCy is intended to provide a broader and more collaborative interaction with the student than a tutor typically provides. CPT LuCy's purpose in PRAXIS is not to coach the student by reporting mistakes, or reveal solutions to the exercises, but instead to provide a more supportive environment for the student by encouraging reflection and articulation and discussing future intentions and their consequences. While both CPT LuCy and the tutor in PRAXIS interrupt the student, they do so in different ways. The tutor interrupts the student to provide corrective feedback when the student takes a conclusive action that leads to an incorrect solution, such as linking a mission threat to an unrelated piece of evidence. In the case where the tutor would interrupt to say, "That's an invalid link," CPT LuCy would say, "I don't think linking that evidence to that threat was a good idea. Why did you do that?" (see Figure 2). By

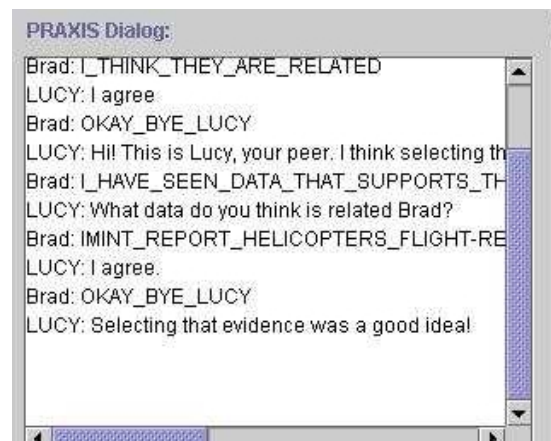
Figure 2. Unsolicited Feedback from CPT LuCy



stating the interruption as an opinion, CPT LuCy gives the student the opportunity to agree or disagree. CPT LuCy forces the student to evaluate a decision by asking why the student took an action and encourages consideration of the implications of the action. The student's response could also provide useful information about the student's reasoning for the student model, and this information could be used by the tutor to better tailor coaching to the student's needs. For example, if CPT LuCy is incorrect, and the student's linking of the evidence to a particular mission threat is correct, the level of understanding and confidence that the student has about their action will be revealed in how the student responds to CPT LuCy. If the student backs down and agrees with CPT LuCy, then the student model could note that the student really did not understand the reasoning behind their action. The tutoring system could then provide related exercises to further the student's understanding. If the student does not back down, the student model could record the student has a deep understanding of the reasoning behind their decision.

CPT LuCy also provides motivation for the student through positive reinforcement. When CPT LuCy decides the student has taken a good action, a dialogue box is presented indicating such as shown in Figure 3. Such motivation helps keep a student on track during their problem solving.

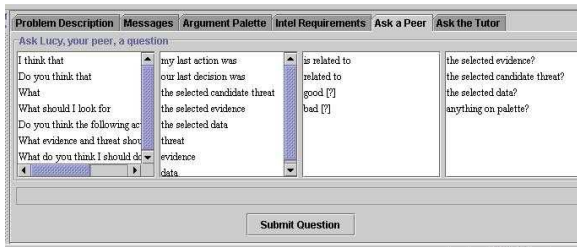
Figure 3. Positive Reinforcement from CPT LuCy



The student can also initiate a dialogue with CPT LuCy to get advice on how to proceed or request feedback on previous actions (Figure 4). In contrast to the curt dialogue exchange nature of the tutor inquiry component, CPT LuCy's inquiry component is often used as the beginning to an extended dialogue between CPT LuCy and the student. That

dialogue requires reflection and articulation about the problem solving underway.

Figure 4. CPT LuCy Inquiry Interface



in the middle of an extended dialogue, the student makes the statement “There is a threat in the threat table related to it,” CPT LuCy must determine what “it” means. CPT LuCy examines the dialogue history, stored in the Student Model, to make this determination. Once the meaning of the statement is derived, it is added to the dialogue history. This information could be used to augment other parts of the student model. For example, if the student asks for help in applying a particular rule, the information in the student model regarding the rule can be updated to indicate the student is having trouble with the rule.

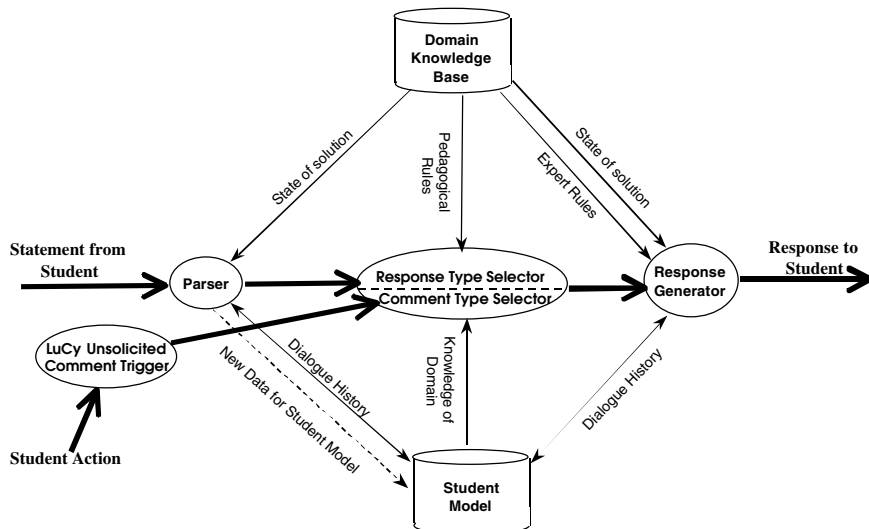
CAPTAIN LUCY’S ARCHITECTURE

This section describes CPT LuCy’s underlying architecture, and the methods by which our companion constructs responses to student questions and comments. Figure 5 gives an overview of the architecture underlying CPT LuCy and shows how a single exchange with CPT LuCy proceeds. Consider a request solicited by the student. The student inputs a request using the inquiry interface. First, the statement from the student is parsed. CPT LuCy must determine what the student has asked or stated. Since the input is through a menu-based interface, there are a limited number of statements the student can make; however, there is a great deal of context that must be taken into consideration to determine the exact meaning of the statement. For example, if the student asks “Do you think that my last action was good?”, CPT LuCy must determine which action the student is referring to by retrieving the current state of the solution from the domain knowledge base. If,

The student could also evoke CPT LuCy as a side-effect of an action taken by the student. CPT LuCy has situations associated with actions that are stored as triggers for unsolicited comments. A trigger determines if a comment is warranted and then, by examining the student model and dialogue history, whether CPT LuCy should in fact proceed ahead and make a comment at that point in the problem-solving activity.

The next step for CPT LuCy, whether or not a remark is solicited or unsolicited, is to determine the type of response or comment to give the student. CPT LuCy determines how well the student understands the knowledge and rules that relate to the input statement by examining the student model. The information is combined with pedagogical rules, stored in the domain knowledge base, to determine whether CPT LuCy should give a correct or buggy response. If the student does not know the rules in question, CPT LuCy is more likely to provide correct answers. However, if the student shows understanding of the

Figure 5. CPT LuCy's Architecture



knowledge to some degree, it might be instructionally valuable for the student to be challenged to defend their understanding. CPT LuCy may give an incorrect response, in order to begin an argument, compelling the student to justify their position.

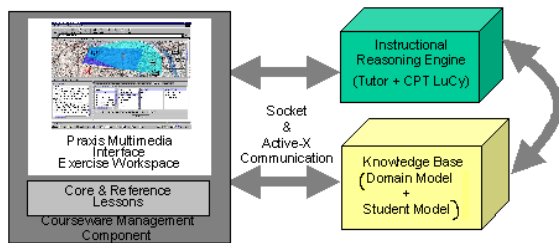
Lastly, a response to the student is generated by constructing text that reacts to the student's statement or action. The details indicated by the student of interest in the argument table and message traffic browser that make up the solution state are consulted to make the response relevant. The previous dialogue history from the student model is used to ensure a natural flow to the conversation. The generated response is added to the Dialogue History, and presented to the student. Again, Table 1 presents an example dialogue.

PRAXIS, THE INSTRUCTIONAL SYSTEM

The PRAXIS instructional environment, as shown in Figure 6, provides a learning experience for students through scenario-based exercises, computer-based training on core domain and reference materials, and background materials. A courseware management component, built using Asymetrix Librarian®, controls instructional activities and monitors and records student progress. The PRAXIS-VTOC provides a set of tools used in map-oriented exercises and serves as the student interface to the instructional system. The exercises are solved by the student using the PRAXIS-ITS and PRAXIS-CBT. The PRAXIS-ITS is an intelligent tutoring system that includes an assortment of problem-solving tools and a simulated learning companion that works alongside the student to help the student solve exercises. The PRAXIS-CBT is the computer-based training component of the system that offers lessons on both core domain and background reference materials.

Table 3 summarizes the tools that are part of each of

Figure 6. PRAXIS Instructional Environment



these components and describes how these components interact with the student or other PRAXIS components. The courseware management

Table 3. PRAXIS Components

Component	Tools	Interaction
CMI Module & Database	Asymetrix Librarian®	Student Login Dialogue Boxes
	Microsoft SQL Server®	TCP/IP
PRAXIS-ITS	CPT LuCy	Natural Language Dialogue
	Tutor	Natural Language Dialogue
PRAXIS-VTOC	Message Traffic Browser	EMAIL Display Window
	Dialogue History	Window
PRAXIS-CBT	Exercise-specific (e.g., argument table)	Windows, Tables, Dialogue Boxes
	MapEdit 2-D	Dialogue Boxes, Graphics Interface
PRAXIS-VTOC	3D Navigation & VRML Terrain Viewer (Blaxxun®)	Graphics Interface
	Core Lessons	Integrated Media
PRAXIS-CBT	Reference Lessons	Web pages
	Help/Reference Materials	Web pages
PRAXIS-CBT	Notepad	Free text
	EMAIL	Window

component, PRAXIS-VTOC, and PRAXIS-CBT are being developed by Global Information Systems Technology, Inc. The PRAXIS-ITS is being developed by the MITRE Corporation.

Learning Management System. The PRAXIS courseware management component serves as the computer managed instruction (CMI) element. The CMI provides a login sequence to start a student's instructional session, determine state, and direct new instructional activity. The CMI allows a student to suspend or end the current instructional activity. The student state is recorded in a database on the PRAXIS Server upon completion of each instructional activity and at the end of each session.

Learning Companion. The PRAXIS-ITS, in conjunction with the PRAXIS-CBT, is where the student is presented complex exercises to practice their knowledge of the S2 intelligence domain. The PRAXIS-ITS provides the student with a set of

loosely-coupled tools that the student can choose to help devise and justify a solution. Tools include a message browser for reading simulated message traffic, an argument table for representing reasoning about whether or not a particular entity is a threat to the mission, and the MapEdit tool provided by PRAXIS-VTOC for representing the tactical situation. The PRAXIS-ITS provides two intelligent agents that can interact with the student during the problem-solving process – a Tutor and CPT LuCy, the Learning Companion. The Tutor, which attempts to simulate a human instructor, only interacts with the student upon their request. It can provide hints and answer questions. CPT LuCy, described in detail earlier in this paper, can interrupt on its own volition, providing comments on a student's actions and hints on how to proceed.

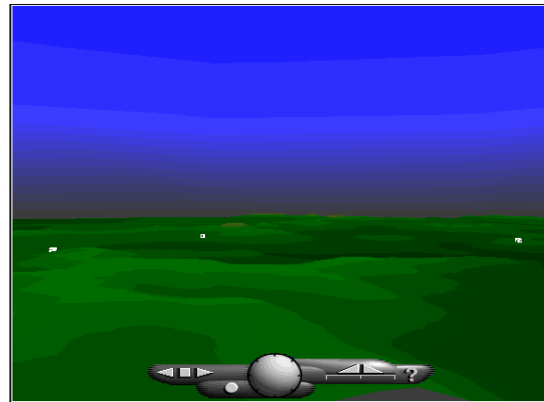
VTOC. The Virtual Tactical Operations Center (VTOC) is a distributed virtual environment in which a student can access problem-solving activities, tools, reference materials, and human peers and instructors to assist in developing competence in core aspects of battlefield preparation (Paschetto et al., 1999). It was originally designed for the Armor Captains Career Course (AC3) as a multi-user, multi-tasking virtual environment to train captains to command companies and be assistant operations officers at battalions and brigades (Paschetto et al., 1999). The Intelligence Center uses VTOC for synchronous training. For PRAXIS, VTOC was extended to operate in a single-user mode as part of the Military Intelligence Captains Career Course (MICCC). CPT LuCy, the Learning Companion, provides collaboration absent human peers. The VTOC environment in PRAXIS consists of three major components (Wheat, 2000):

MapEdit. This tool, shown in Figure 7, is used to produce products associated with the exercises

assigned to a student to help them master the MICCC materials. MapEdit employs a two dimensional map and a toolbox of objects and drawing tools to produce overlays on the map. MapEdit is the central place for most MICCC exercises. Figure 7 shows a tactical situation represented in MapEdit. (Wheat, 2000)

VRML Terrain Viewer. This tool, shown in Figure 8, helps students analyze and prepare solutions by providing a virtual three-dimensional terrain view referenced with a corresponding map. The tool

Figure 8. VRML Terrain Viewer



synchronizes the location of all 3-D representations associated with the 2-D objects templated on the map. The VRML Terrain Viewer helps the student visualize the terrain while they plan which actions should be taken. (Wheat, 2000)

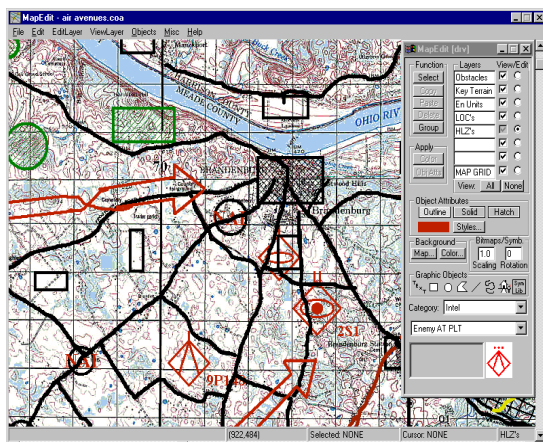
3D Tent. This tool, shown in Figure 9, provides a three-dimensional view of a Tactical Operations Center (TOC). This virtual TOC consists of a main

Figure 9. 3-D Tent Navigator



tent and six sections. A TOC is where students in future assignments as a unit intelligence officer, are expected to perform the same work they master

Figure 7. Mapedit



during MICCC lessons. Access to all tools, core, and reference materials supporting a particular lesson are accessible in the 3D Tent. (Wheat, 2000)

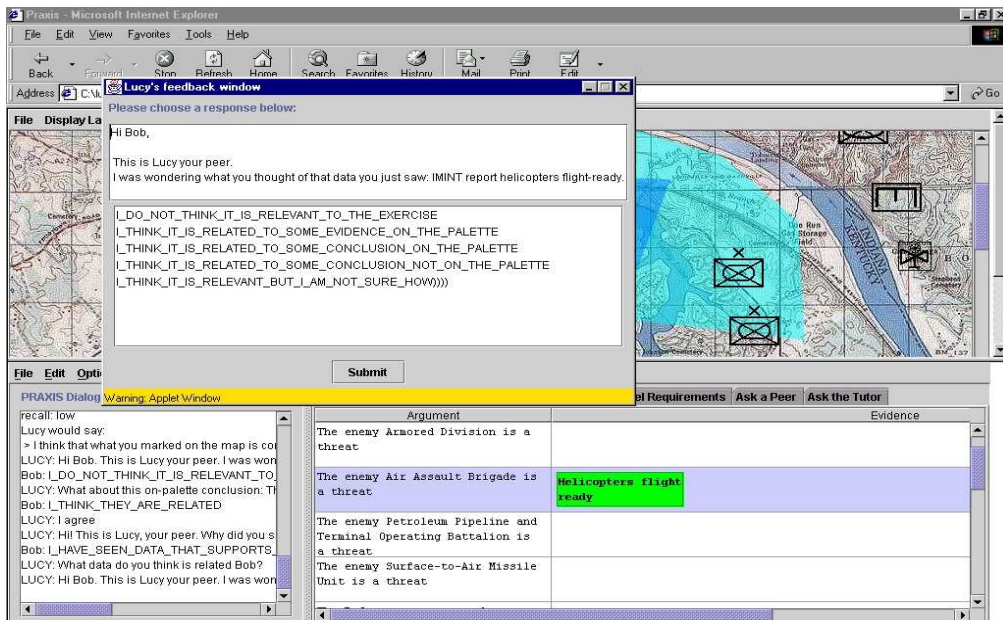
Core and Reference Lessons. The PRAXIS-CBT provides instruction on core S2 intelligence domain areas – Intelligence Preparation of the Battlefield, Mission Analysis, Collection Management, Reconnaissance and Surveillance, and Targeting. The student navigates through the Main Tent to receive a mission statement and then moves to the S2 section of the tent. In the S2 section, the student uses VTOC as the main environment to work on their mission. Instructional aids, such as a checklist or multimedia presentation, are available to help the student. The student receives feedback on the consequences of their work and prescriptions on how to improve before beginning another mission. The student progress is recorded on the server side CMI database. PRAXIS-CBT also has reference lessons that provide relevant knowledge and perspective to support products developed in core lessons. PRAXIS-CBT exercises are integrated with PRAXIS-ITS for portions of Intelligence Preparation of the Battlefield instruction.

Figure 10 is a sample of PRAXIS in the current design. Development of PRAXIS is scheduled for completion and deployment in Fall 2000. Evaluation of PRAXIS will be performed by the Air Force Research Laboratory and the U.S. Army Training and Doctrine Command .

CONCLUSIONS AND FUTURE DIRECTIONS

Constructivist learning can help the military train personnel to construct the solutions they require to address unknown military situations as they arise. The constructivist and peer-supported strategy advocated by this paper will be put to the test when PRAXIS is deployed in Fall 2000 to Army captains enrolled in the Military Intelligence Captain’s Career Course at the Intelligence Center at Ft. Huachuca. Peer learning is clearly an important component to learning. PRAXIS attempts to provide the benefits of peer learning through CPT LuCy as a way to compensate for arbitrary human peer availability. Evaluation of the performance of the PRAXIS users on the Brigade Operations and Intelligence Exam currently taken by MICCC participants will provide valuable insights on the PRAXIS learning strategies. We expect collaboration to remain an issue as we continue to develop soldiers who are better thinkers. A potential next step is to find a way for asynchronous learners to become engaged in collaborative, and possibly, time shifted synchronous activities using powerful distance learning techniques. We are investigating the development and use of a problem-solving replay tool that allows an asynchronous learner to replay a synchronous session in its full fidelity.

Figure 10. PRAXIS-ITS CPT LuCy Interruption



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