DOCUMENT RESUME

ED 466 215 IR 021 286

AUTHOR	Sheremetov, Leonid; Tellez, Rolando Quintero
TITLE	EVA: Collaborative Distributed Learning Environment Based in Agents.
PUB DATE	2001-00-00
NOTE	7p.; In: ED-Media 2001 World Conference on Educational Multimedia, Hypermedia & Telecommunications. Proceedings (13th, Tampere, Finland, June 25-30, 2001); see IR 021 194. "Work supported in part by REDII CONACyT and CGEPI IPN."
AVAILABLE FROM	Association for the Advancement of Computing in Education (AACE), P.O. Box 2966, Charlottesville, VA 22902 ($40, AACE members; $50, nonmembers). Tel: 804-973-3987; Fax: 804-978-7449; Web site: http://www.aace.org.
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Computer Software Development; *Computer System Design; Cooperative Learning; *Distance Education; Educational Environment; Educational Technology; Foreign Countries; *Intelligent Tutoring Systems; Spanish; *Web Based Instruction; World Wide Web
IDENTIFIERS	Mexico

ABSTRACT

In this paper, a Web-based learning environment developed within the project called Virtual Learning Spaces (EVA, in Spanish) is presented. The environment is composed of knowledge, collaboration, consulting, experimentation, and personal spaces as a collection of agents and conventional software components working over the knowledge domains. All user interfaces are Web pages, generated dynamically by servlets and agents. Each EVA host has an agent associated with it, which can establish links with the other EVA hosts forming shared knowledge and collaboration space of a distributed EVA learning environment. This paper focuses on the description of the system architecture, implementation of software modules, and the application results. Experiments to date have demonstrated the high flexibility of the EVA multiagent system (MAS) as well as the interoperability with non-agent software modules. Some difficulties have been detected with the proposed architecture, for example, all the agents and protocols must exist (be active or able to be initialized automatically) for a service to be provided. There have also been some problems accessing different databases with JDBC drivers on the WindowsNT platform. Nevertheless, the expectation is that as the set of agents grows, the development will be easier. (Contains 15 references.) (AEF)

EVA: Collaborative Distributed Learning Environment Based in Agents

Leonid Sheremetov
Computer Science Research Center, National Technical University (CIC-IPN),
Av. Juan de Dios Batiz Esq. Othon de Mendizabal s/n
Col. Nueva Industrial Vallejo, 07738 Mexico, D.F., Mexico
sher@cic.ipn.mx

Rolando Quintero Téllez
Computer Science Research Center, National Technical University (CIC-IPN), Mexico
Av. Juan de Dios Batiz Esq. Othon de Mendizabal s/n
Col. Nueva Industrial Vallejo, 07738 Mexico, D.F., Mexico
quintero@cic.ipn.mx

Abstract: In this paper, a Web-based learning environment developed within the project called Virtual Learning Spaces (EVA, in Spanish) is presented. The environment is composed of knowledge, collaboration, consulting, experimentation and personal spaces as a collection of agents and conventional software components working over the knowledge domains. All user interfaces are Web pages, generated dynamically by servlets and agents. Each EVA host has an agent associated with it, which can establish links with the other EVA hosts forming shared knowledge and collaboration space of a distributed EVA learning environment. The article focuses on the description of the system architecture, implementation of software modules, and the application results.

Introduction

The technological innovations on the one hand, and the growing popularity and availability of Internet on the other, are the main reasons of development in the last years of numerous applications and investigation projects in the field of technology-mediated education (Youngblut, 1994; O'Malley, 1995; Hamouda & Tan, 2000). The virtual teaching, integrating computer and communication technologies in different educational scenarios, is advocated as a solution to the problem of exponential growth of knowledge in the contemporary society (Collis, 1999). As a matter of fact, information technologies offer exciting opportunities to thoroughly redesign the education process and to achieve, among others, the following benefits: integration of means (text, audio, animation and videotape), interactivity, access to big quantities of information, plans and individualized work rhythms and immediate answer to the apprentice's progress.

However, the introduction of the technologies in the real education environment is a difficult problem. Therefore, the intense search of new pedagogic solutions and teaching/learning technologies is a time challenge, where the advanced information technologies play the main role. The EVA *(Espacios Virtuales de Aprendizaje in Spanish - Virtual Learning Spaces)* project is dedicated to the development and implementation of a Distributed Learning Environment (DLE), personalized and collaborative, by means of which different academic and administrative activities can be offered in a distance manner to the students of different institutions and public and private companies (Nuñez et al., 1998; EVA, 2000).

EVA is a learning paradigm that considers different forms of acquiring, transmitting and exchanging knowledge among people and work groups that don't usually have physical access to the conventional sources of knowledge: books, magazines, schools, universities, laboratories, libraries, good professors, etc. EVA constitutes a conception of the education that uses advanced information technologies like, for instance: JAVA servlets and applets, Multiagent Systems (MAS), Groupware, Multimedia and Virtual Reality (VR). The EVA system is also composed of a number of authoring tools for virtual teaching and learning according to the EVA methodology. The main two authoring systems are: visual environment for the development of Multibooks, *ELVA* - an auxiliary tool facilitating the development of learning materials; and a CASE tool for the development of VR worlds with complex behaviour of their components: EASYVRML facilitating the development of virtual laboratories and simulations in VR. (Quintero, Armenta, Balladares & Nuñez, 1998).

The EVA philosophy is congruent with the existing classroom practice: mainly aims at learning goals and outcomes that are already embedded in traditional curricula, do not neglect the use of conventional learning materials, and can usually be plugged into existing curricula with minimal change to course plans. It benefits from explicit representation of the topics that students investigate, but it doesn't need to be omniscient. Further, since EVA does not attempt to tutor, it is free of obligations to model students' cognition and to make complex pedagogical decisions. In the rest of the article, the architecture of EVA environment, implementation of software using Java servlets and agents, and the application results are considered.

EVA architecture

The conceptual architecture of EVA is structured into the four essential learning elements, called Virtual Learning Spaces. These spaces are: *knowledge* - all the necessary information to learn, *collaboration* - real and virtual companions that get together to learn, *consulting* - the teachers or tutors (also real and virtual), who give the right direction for learning and consult doubts, and *experimentation* - the practical work of the students in virtual environment to obtain practical knowledge and abilities. These four spaces are complemented with the *personal space* where user-related information is accumulated. These spaces are supported by a number of tools developed using different information technologies (fig. 1).

The knowledge space is composed of a set of "*Multi-books*" (or *POLIlibro*, in Spanish), personalized electronic books, generated by concatenating selected Units of Learning Material (ULM) along the learning trajectory for each knowledge domain. Planning of learning trajectory for students who navigate in EVA (they are called EVAnauts) in discretized knowledge space allows a student to establish her own route and learning rhythm, according to her scientific and professional interests, to the time and resources at her disposal, making possible to combine her more immediate requirements with the long term objectives.

The systems of virtual education traditionally use the client-server architecture since it is the basic principle of operation of the Web: a user (client) by means of a browser requests a service (pages HTML, etc.) from a computer that serves as a server. Usually, in the DLE each user has a personal account at the corresponding DLE server, which makes it impossible to share similar learning activities with students and tutors subscribed to another DLE servers, even in the case they use the same environment. EVA, also using the client/server architecture, tries to solve this problem making use of agent technology (see the next section for details).

The EVA environment is installed on the servers which we call EVA nodes. It is formed by the HTML pages, Java programs (Applets and Servlets), a number of MAS and a database (Sheremetov & Núñez, 1999a; Peredo, Armenta & Sheremetov, 1999). To customize the learning spaces for each user, we have adopted the technology of dynamic page and link generation and interactive pages using *servlets, applets and agents* (fig. 2). For the client's request, a servlet communicates with the database by means of the SQL (Structured Query Language) and generates the answer as an HTML page in the client's navigator. The servlets, being programmed in Java operate with controller JDBC (Java Dates Base Connectivity) to access databases. Since the controller ODBC (Open Dates Base Connectivity) is used by Windows, a controller bridge between Java and OBDC is required, that allows the servlets to operate with the database. Java Web Server (JWS) or Apache Web Server are used to mount servlets, which so far constitute the concept of virtual classroom and virtual laboratory providing flexible mechanism to communicate with the database manager that manipulates the entire page related information. EVA user interface generated by EVA servlets is shown in fig. 3.

At the current stage of our experiments, the EVA environment as it is configured in the CIC-IPN, makes use of a number of servers each playing different functional role. *Server EVA* uses Apache Web Server, installed in a ULTRA SUN 10 work station to host the static information of the system related with the educational material included in the Multibooks, the personal Web accounts of the professors and students and the security system. It serves as a gateway to the rest of the system. *Server HERA* is the main server of the EVA environment. It also makes use of Apache Web server and is dedicated to the generation of dynamic pages and transmitting them via *http* to the client machine. The server is a PC computer with microprocessor Pentium III Dual at 500 MHz. The database for the operation of the system is installed in this server. Finally, *server AGENTES* uses a JWS server installed in a PC computer with microprocessor Pentium III Dual at 500 MHz. It serves to store the information related with the videoconferences and video-on-demand, as well as to host platforms for the MAS of different purposes.

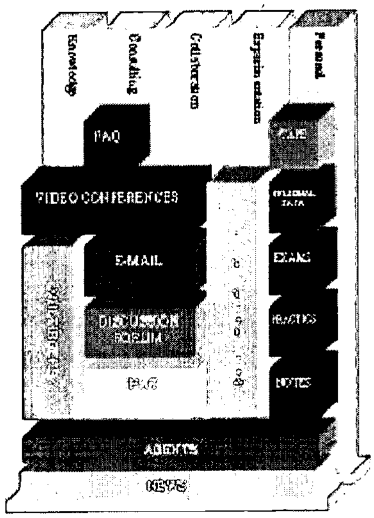

Fig. 1. Learning spaces and tools distribution

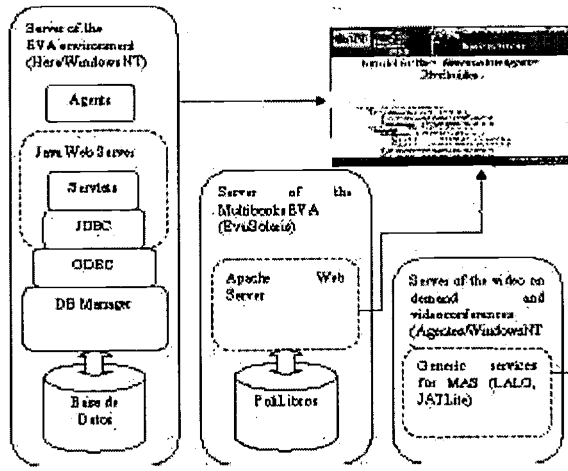

Fig. 2. Software architecture of the EVA environment

Actually, the architecture described above is not that fixed. Each node of EVA controls the corresponding knowledge domain. It means that all the information about the ULMs pertaining to it is stored in the database. So each ULM, which forms the content of Multi-books may have its own location specified by the URL in the database, and there is no need to have all the materials on the main server (*EVA*, for example). Sure, knowledge domains are interrelated between then, so usually to study in EVA means to study Multibooks pertaining to different domains. In other words, the distributed model of the knowledge space is needed, which integrates these parts into the common knowledge space. It is done by means of the use of domain agents carrying out trajectory planning functions. In the same way, the MAS of the personal assistance permits to generate groups of students with common interests physically connected to different EVA nodes.

At the current stage of our experiments, the architecture illustrated in fig. 4 is used. This figure shows an excerpt from the model actually implemented in the IPN creating groups of users from different colleges having similar study plans. Each client uses a Web navigator to communicate with his EVA server (where he is registered). However, his personal assistant agent establish communication with the personal assistants of his working group (possibly registered to other servers) and, if needed, with the domain planning agents to create virtual distributed learning space for each particular user. The next section explains it in more details.

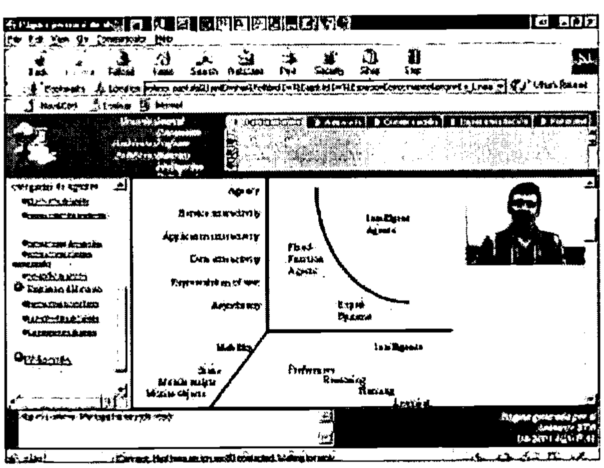

Fig. 3. EVA user interface: Multibook "Intelligent Distributed Systems"

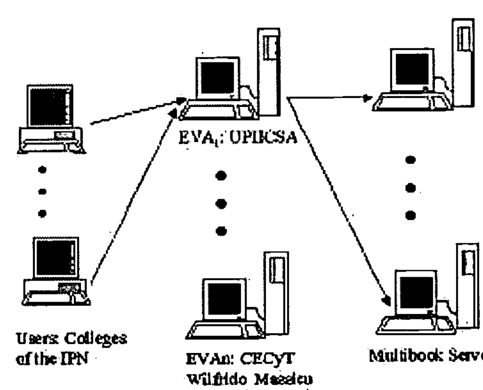

Fig. 4. Software architecture of the distributed EVA environment

Multi-agent Systems in EVA

As it was already mentioned, while implementing EVA, we have detected several problems of the traditional client-server architecture that impel the search of new solutions in the organization of environments of distributed software and the software for the Internet. One of these technologies of recent creation is the technology of agents, which seems to be a promising way to approach the problem of DLE development. The notion of agents is the central part of contemporary learning environments, where they act as virtual tutors, virtual students or learning companions, virtual personal assistants that help students to learn, mine information, manage and schedule their learning activities (Müller, Wooldridge & Jennings, 1997; Chan, 1996; Gordon, & Hall, 1998). One of the main purposes of our project is to develop models, architectures and multi-agent environment for collaborative learning and experimentation.

The core of the EVA environment consists of a number of components, composed of a set of deliberative and auxiliary agents, forming three multiagent systems: a virtual learning community, a multiagent planning system and a multiagent virtual space of cooperative experimentation. For details of these MAS implementation see (Sheremetov & Núñez, 1999a, Sheremetov & Núñez, 1999b). In the learning spaces, students and tutors receive help from their *Personal Assistants*. Personal assistants (PA) is a class of intelligent agents that act semi-autonomously on behalf of a user, modeling his interests and providing services to the user or other PA's that require it. PA has the following functions, implemented as plug-ins of the PA's kernel (fig. 5):

- Implements environment for collaborative problem solving. Helps tutors, coordinating collaborative activities. It can give privileges in the acceptance of the contributions, define the problem to discuss, among others. Helps students, regulating their participation in the discussion, showing coordination messages, etc.
- Implements a News system for the communication between students and professors.
- Implements a system of Electronic Agenda where all the information on the student's activities is stored.
- Implements the structured Chat tool with the possibility of the users' connection registered in different EVA environments.

In the Collaboration Space, our prototype of learning community incorporates also a *Group Monitor agent*. Agents have mental states represented in terms of beliefs, knowledge, commitments, with their behaviour specified by rules. A *Group Monitor Agent* maintains the shared knowledge model of a group and compares it with a group problem model from the knowledge base that contains the objectives, concepts, activities, etc. that characterize a group. His behavior is guided by a set of domain independent conversation rules, which refers to the interactions between the group members. During the group session, the monitor agent maintains the current problem state (shared group knowledge space) and the history record of all contributions for each participant. The problem state in terms of shared beliefs and knowledge is used to change the interaction mode, choosing one of monitoring techniques from his rule base. This result in changing behavior of learning companion from group leader (strong companion) through a week companion to a passive observer. User interface of this collaborative environment is shown in Fig. 6.

Personal assistant is implemented as Java Application and can be loaded in any computer with Java support and Internet connection. With this, we can say that each user will have a PA agent according to the social role that plays in the cooperative environment, as a tutor or a student. The personal data for each user are stored in EVA's database, so, when being invoked, his PA will already have a previous knowledge about the person to whom it assists and of the social role that he plays in the environment. Two types of utility Agents are also used in this MAS, a *Broker Agent* (or Directory Facilitator) and a *Wrapper Agent*. The first of them is considered a service facilitator, since for any Assistant (Professor or Student) it will look for the services provided by other agents and other assistants. Wrapper Agent can be defined as DB service provider, because it administers the EVA database with the purpose of consulting and it's modification in an explicit way (fig. 5). All the agents use Knowledge Query and Manipulation Language (KQML) for communication.

Prototypes of agents have been developed using Microsoft VC++, LALO, JAVA, and JATLite with rule-based inference capabilities, programmed in Jess (Friedman-Hill, 1998; JATLite, 1998). *Personal Assistant and Planning* agents are Java applications implemented with Swing package of the JDK 1.2 development environment and with the integration of a Java component for the creation of JATLiteBean agents.

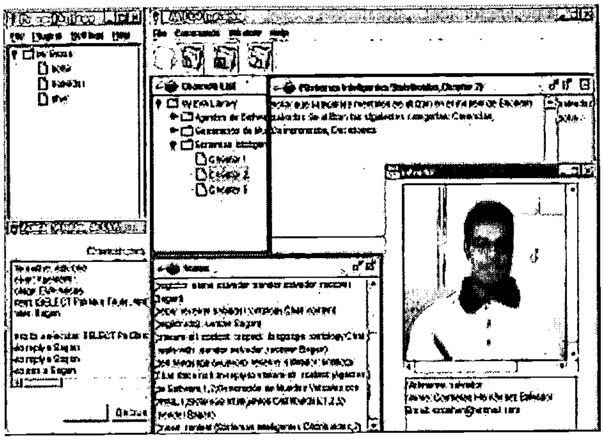

Fig. 5. Interface of the PA environment

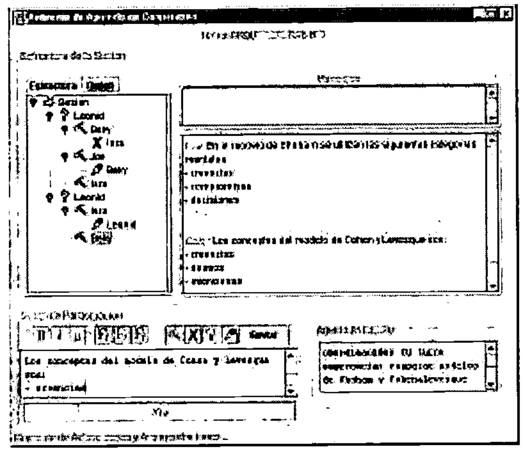

Fig. 6. User interface of the collaborative environment maintained by the PA Agent

Current experiments and conclusions

At the moment of writing, the first version of EVA is in the implementation and testing phase. The following results have been obtained since it was launched:

1. In the fall semester of 1998, the EVA environment was first used to impart the seminar of Software Agents in the CIC. The server was accessed by near 20 students from the PC's of the LAN of the CIC and from remote computers from the periphery of Mexico City, from an approximate distance of 50 miles. Since then, the EVA environment and the Multibooks have been used by the professors of the CIC as an additional didactic support in the Postgraduate courses in Computer Sciences.
2. Started in October, 1999, the first international course in EVA called "The digital documentation in means of social communication" was imparted twice, jointly by the Center of Training of Educational Television (CETE) of the General Direction of Educational Television of Mexico and the Complutense University of Madrid, with the participation of students from Mexico, Colombia, Argentina and the Dominican Republic.
3. Also in October, 1999, under the supervision of the Coordination of Academic Computation of the IPN, the development of the institutional project "Installation of the model and system EVA (virtual spaces of learning) in the IPN" has begun. This project has as objective to support the educational modernization of the IPN, taking advantage of the methodology and the EVA software environment, within the framework of the Program on Educational Technology for Academic Innovation. The EVA environment is installed at the servers of diverse schools and colleges of the IPN, as, for example, UPIICSA, CECyT Wilfrido Massieu, CECyT 6, which serve as nodes in the training network and in developing of the corresponding Multibooks.
4. Starting in October 2000, the Virtual Master's Degree Program in Computer Science using EVA as a platform of distance education for the students from the system that integrates about one hundred of Technological Institutes in Mexico has also begun. Only 50 students have been admitted for the first stage of this experiment after presenting their admittance exams in EVA. Four Technology Institutes were selected through Mexico as regional sites, where EVA nodes have been installed enabling 4-nodes distributed Virtual Postgraduate Department.

We have also begun to work on the digital library of the CIC and the National Library of Science and Technology (BNCT) of the IPN that will allow to have an interactive portal of the BCNT that takes advantage of all the benefits of the ATM network using an EVA-like middleware written in Java. The digital library will de integrated into the current version of EVA environment which is under development to enable the creation of a virtual campus EVA-IPN.

Our experiments to-date have demonstrated the high flexibility for the EVA MAS system as well as the interoperability with non-agent software modules. We have also detected some difficulties while working with the proposed architecture. For example, all the agents and protocols must exist (be active or able to be initialized automatically) for a service to be provided. Also, working with different databases, we have detected some problems when accessing them with JDBC drivers on WindowsNT platform. Nevertheless, our expectation is that as the set of agents grows, the development will be easier.

The work on virtual learning community, composed of learning companions and personal learning assistants is in process. We have developed a number of prototypes but a lot of work is still to be done to convert them into a real DLE.

Acknowledgements

The EVA project is the effort of many people. The author would particularly like to thank his colleagues and students of the Agents Laboratory for their determination and contribution of ideas and talent to EVA programming. This work was supported in part by REDII CONACyT and CGEPI IPN.

References

Chan, T.W. (1996) Learning companion Systems, Social Learning Systems, and Intelligent Virtual Classroom, In *Proc. of the World Congress on AI in Education*, 1996, Vol. 7, No. 2, 125-159.

Collis, B. (1999) Applications of Computer Communications in Education: An Overview. *IEEE Communications Magazine*, March 1999, 82-86.

EVA (2000), EVA environment v1.0, http://eva.cic.ipn.mx

Friedman-Hill, E. J. (1998), Jess, The Java Expert System Shell, Version 4.3, Technical report SAND98-8206 Sandia National Laboratories, Livermore, CA, http://herzberg.ca.sandia.gov/jess.

Gordon, A. & Hall, L. (1998) Collaboration with Agents in a Virtual World. *In Proc. of the Workshop on Current Trends and Artificial Intelligence in Education, 4 World Congress on Expert Systems*, Mexico-city, Mexico, 1998.

JATLite Beta Complete Documentation (1998), Stanford University, http://java.stanford.edu

Hamouda A.M.S. & J.P. Tan. (2000) Development of Virtual Classroom for Interactive Education on the Web, In *Proc. of the International Conference in Digital University*, 16-17 May 2000, KL, Malaysia.

Müller, J., Wooldridge, M. J. & Jennings, N. R., eds. (1997) Intelligent Agents III: Proc. of the 3rd Int. Workshop on Agent Theories, Architectures, and Languages, *Lecture Notes in Artificial Intelligence*, Vol. 1193, Springer-Verlag.

Nuñez, G., Sheremetov, L., Martínez, J., Guzmán, A., De Albornoz, A. (1998) The EVA Teleteaching Project - The concept and the first experience in the development of virtual learning spaces. In Gordon Davies (ed.) *Teleteaching'98 Distance Learning, Training and Education: Proceedings of the 15th IFIP World Computer Congress "The Global Information Society on the Way to the Next Millennium"*, Vienna and Budapest, 31 August - 4 September 1998, Part II, pp. 769-778.

O'Malley, C. (1995) *Computer Supported Collaborative Learning*. Springer Verlag.

Peredo R., Armenta A. & Sheremetov L. (1999) Arquitectura Computacional para Sistemas de Aprendizaje Colaborativo, In Proc. of the *Simposium Internacional CIC'99*, 15-19 de noviembre 1999, pp. 628-636. (in Spanish).

Quintero, R., Armenta, A., Balladares, L. & Nuñez G. (1998) EasyVRML Herramienta CASE para la asignación de comportamiento a componentes de mundo VRML. In Proc. *XI Congreso Nacional ANIEI*, Mexico, 1998.

Sheremetov, L. & Núñez, G. (1999a) Multi-agent framework for virtual learning spaces. *Int. Journal of Interactive Learning Research (JILR)*, 10(3-4):301-320.

Sheremetov, L. & Núñez, G. (1999b) Multi-Stage Cooperation Algorithm and Tools for Agent-Based Planning and Scheduling in Virtual Learning Environment, In Proc. *of The First International Workshop of Central and Eastern Europe on Multi-agent Systems (CEEMAS'99)*, 30th May-3rd June 1999, St. Petersburg, Russia, pp. 211-223.

Youngblut, Ch. (1994) Government - Sponsored Research and Development Efforts in the Area of Intelligent Tutoring Systems. *Institute for Defense Analyses*, USA.

NOTICE

Reproduction Basis