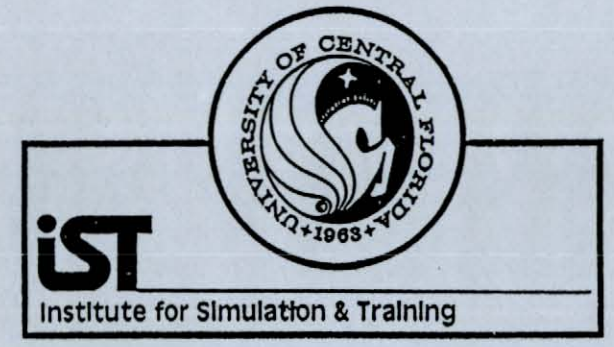
1-1-1989

Below Average Mathematics Student Improvement Program And The Classroom Of The Future

Julia A. Medin

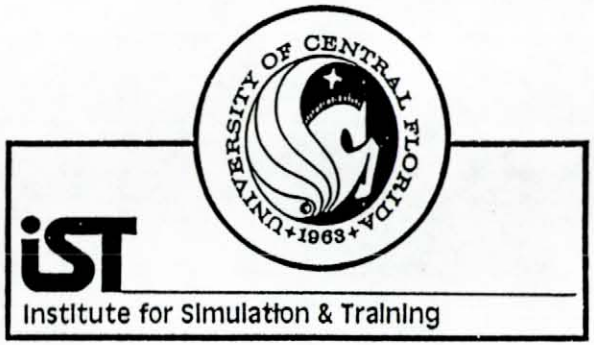
Below Average Mathematics Student Improvement Program and the Classroom of the Future



Institute for Simulation and Training
University of Central Florida
Orlando, Florida

March 24, 1989

Below Average Mathematics Student Improvement Program and the Classroom of the Future



Institute for Simulation and Training
University of Central Florida
Orlando, Florida

March 24, 1989

Contents

PROPOSAL SUMMARY

PROBLEM

- Many public school students have difficulty learning basic mathematics skills.
- Today, a majority of these students are minorities.
- A major issue in the U.S. schools is the lack of properly trained teachers to teach these below average mathematics students.
- There are essentially no public school curricula for the below average methematics students. Only band-aid techniques are available.

WHAT IS NEEDED

- Develop curricula for the below average mathematics students combining classroom teaching strategies with computerized artificial intelligence tutoring and other technologies.

- Develop programs to prepare teachers for the below average mathematics students (eventually may be combined with below average science students).

UTILIZATION OF PRIOR INVESTIGATIONS

- Artificial intelligence has been used to simulate cognitive processes such that computer software can reproduce the way in which humans learn, perceive, reason and communicate.

- Test anxiety and locus of control orientation studies have demonstrated their relationship to student math acheivement.

PROPOSED INVESTIGATION

- Artificial intelligence (AI) techniques developed from Department of Defense. R & D investigations will be used as a basis to develop curricula and new teaching techniques for below average Junior High School math students.

- Education specialists who have performed R & D on below average math students and the AI experts will determine the proper balance of computer use and other improved classroom assignments.

PROPOSED INVESTIGATION (CONT)

- A two year development program will be undertaken to perform research in developing curricula and qualified teachers. The developed curricula will combine classroom teaching strategies for below average math students with computerized artificial intelligence tutoring and other technologies.

- Student investigations will be aimed at:
  - Means to reduce test anxiety
  - Enhancing the student's confidence and self esteem
  - Means of increasing their math acheivement
  - Locus of control

THE PROBLEM

THE PROBLEM

- Many public school students have difficulty learning basic mathematics skills.
- These students have average or even above average intelligence.
- Today, a majority of these students are minorities.
- These students generally experience intensified test anxiety and external locus of orientation.

THE PROBLEM (CONT.)

- A major issue in the U.S. schools is the lack of properly trained teachers to teach these below average mathematics students.
- Few teachers elect to teach these classes.
- Programs to teach the marginal mathematics students must address their situational emotional difficulties as well as their academic skills.
- Marginal math students, unfortunately, if they go on to college, often will elect elementary education as their major study.
- Basic mathematics skills classes usually have severe discipline problems, making teaching and learning extremely difficult.

U.S. WORK FORCE TRENDS AND NEEDS

- Increasing use of high technology in U.S. industries necessitates that student knowledge of basic skills be drastically improved.
- Today the U.S. has difficulty meeting these needs and all trends indicate an increasing shortage of qualified workers.
- There is an increasingly large number of below average math students in the U.S.
- Below average math students include a far higher percentage of minorities.
- Inadequate curricula are being used to teach these students.
- Few teachers are qualified to teach these students

CURRENT RESEARCH AND DEVELOPMENT

Commercial, Industrial and Military Applications have been the driving force for AI technologies applied to training. Their requirements are seldom those of the schools! R & D by these organizations include:

- Intelligent Tutoring Systems and expert systems which provide a sensitive tutor to the learner.
- Use of computer as a flexible multimedia controller for audio video and graphic representation of information.
- Simulation for laboratory type of interactive experiences (complex microworlds).
- Performance assessment and diagnosis of students conceptual understanding.
- Learner focused research as apposed to traditional curriculum centered approaches of past research.

PROBLEM

- Current technology applications to the classroom involve the use of video cassette recorders and obsolete computer technology for some computer aided instruction in English, math, reading and science. This courseware is not adaptive to student needs.

- Major advances have been made in cognitive science which has deliniated the processes by which humans acquire knowledge.

- AI software techniques can be employed to deliver knowledge in a fashion most compatable with the way in which humans acquire knowledge. This capability is called intelligent computer aided instruction.

- Courseware developed employing AI is adaptive to the diversity of needs of students approaching a 1:1 tutorial environment.

PROPOSED SOLUTION

PROPOSED SOLUTIONS

- There are essentially no public school curricula for the below average mathematics students. Only band-aid techniques are available.
- Teachers are not formally trained to teach below average students.
- Solution: Develop curricula for the below average mathematics students that combine classroom teaching strategies with computerized artificial intelligence and other technologies.
- Solution: Develop programs to prepare teachers for the below average methematics students (eventually may be combined with below average science students).

PROPOSED SOLUTIONS (CONT.)

- A two year development program should be undertaken to perform research in developing curricula and qualified teachers combining classroom teaching strategies for below average math students with AI tutoring and other technologies.

- Student investigations will be aimed at:
  - Means to reduce test anxiety
  - Enhancing the student's confidence and self esteem
  - Means of increasing their math acheivement
  - Locus of control

PROPOSED SOLUTIONS (CONT.)

- Teacher investigations will be aimed at:

  - Determining teacher qualification for teaching these students.
  - Curricula needed to develop such teachers.
  - Tools and teaching aids needed by such students.

PROPOSED SOLUTIONS (CONT.)

- Economics of proposed solutions:
  - An overall analysis will be made to forecast the eventual cost of implementing the above proposed solutions.
  - A cost benefit forecast will be made to show the benefits of these programs.

EXPERIMENTAL BASIS

EXPERIMENTAL BASIS

- Studies of college students have shown that both test anxiety and locus of control orientation significantly affect student math achievement.

- Medin's study (1985) of 300 students in Montgomery County, MD. public schools statistically proved that students in below average mathematics classes:

  - Experience a significantly higher degree of anxiety in testing situations than average or above average students.
  - Feel significantly less in control of their successes and failures (External locus of control).

- The students tested were from three different schools located in three different areas (Urban, Middle Class Suburban, Upper Class Suburban/Urban).

EXPERIMENTAL BASIS (CONT.)

- The size of the experimental samples was much larger than used in previous studies and was for Junior High School students.

EXPERIMENTAL BASIS (CONT.)

- Locus of control orientation was more external for below average students and more internal for accelerated students.
- Locus of control orientation was more external for 8th grade below average math students than for 7th grade.
- Based on these experimental results, Medin employed alternate teaching methods and demonstrated that success is possible in improving the skills of the below average mathematics students.

EXPERIMENTAL BASIS (CONT.)

- Results indicated that test anxiety was found to be significantly related to the mathematics achievement in 7th and 8th grade students.
- Anxiety level was lowest for accelerated students, somewhat higher for average students and highest for below average students.
- Anxiety level was higher for girls than for boys.

MATHEMATICS APPROACH

PROPOSED APPROACHES

- Phases

1. Exploratory
   Literature review
   Consultation with industry, government and academic experts
   Purchase of test hardware
   Assembly of staff

2. Development of preliminary curriculum

3. Testing of curriculum

4. Development of preliminary teaching college curriculum

5. Preparation of final report

PROPOSED APPROACH

- Identify target curriculum for focus of research development and evaluation.
- Review research addressing the variety of software techniques developed or under development which focus upon the problem of student modeling and student diagnosis.
- Specify candidate techniques for identifying the logic of student errors in target curriculum.
- Determine the scope of application of fault identification logic within the domain of mathematics.
- Select and assess logic in manual simulation with teacher and students.
- Modify logic where needed and develop software.
- Implement software and curriculum in classroom of the future.
- Integrate traditional instruction with AI controlled courseware (mix of instruction with device interaction.)

PROPOSED APPROACHES (CONT.)

- Subjects

  High School Students from Orange and Seminole Counties (Florida)

- Scientific investigation may include:

  - Artificial Intelligence
  - Computer Based Teaching
  - Computer Instructor/Multiple Terminal Approach
  - Teaching Aids
  - Multi-Media Approach

INITIAL RESEARCH APPROACH

- Collect data by administering tests for locus of control, test anxiety, math attitude, math readiness, classroom alienation, aptitude, math grades to 6th/7th grade students.
  - Research to get additional information will be performed by direct experimentation of students.
- Perform investigation on relationship between locus of control orientation of 8th grade and 9th grade students and success in algebra and geometry.
- Teachers having had substantial experience with below average classes will be surveyed.
- Teachers of on grade algebra and geometry students will be surveyed.
- Select control group and experimental group.
- Begin program to integrate use of computers with classroom procedures.

RESEARCH AGENDA

- To determine criteria for readiness for abstract thinking.

- To administer selected tests to determine change in math attitude, math readiness, classroom alienation, locus of control orientation, test anxiety.

- Determine if there is a relationship between locus of control orientation and success in algebra and geometry, i.e., is internal orientation needed for abstract thinking.

- Study students who do well in arithmetic but not algebra and geometry. Analysis of preceding courses, text books, course objectives.

- Determine if there is a need to psychologically change student external orientation before higher math is possible.

RESEARCH AGENDA (CONT.)

- Survey teachers as to skills lacking in students whose math grades are "C" or below.

MATH CURRICULA DEVELOPMENT

- Three basic courses will be developed.

  - Basic Arithmetic
  - Algebra Readiness
  - Geometry Readiness

COURSE PROGRAM FOR TEACHERS OF BELOW AVERAGE MATH STUDENTS

- University specialty in teaching below average math students.

  - Teachers in program will experience simulated classrooms of the below average math students.

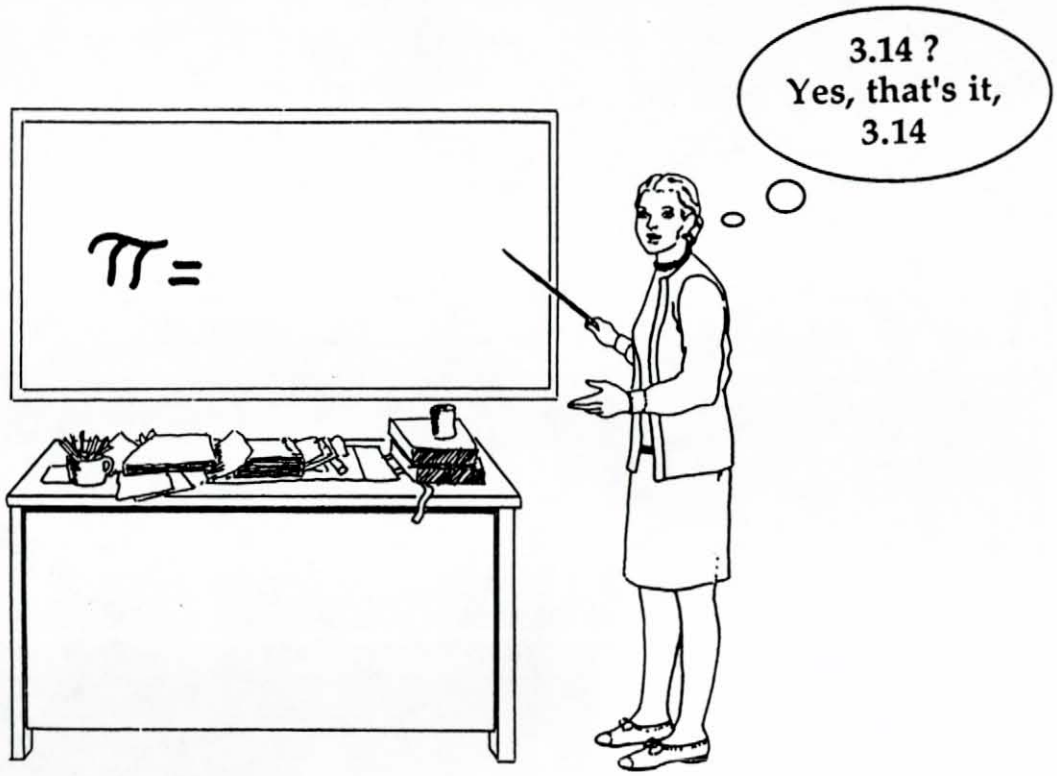
  - Teachers must be trained to manage behavior patterns of marginal math students in Junior High School.

  - Large number of minorities in below averge math classes require input from knowledgeable blacks and Hispanics, psychologists.

- Courses will include
  - Simulated classrooms
  - Psychology of homeless, migrant, other disadvantaged
  - Minority cultures
  - Psychology of learning
  - Teaching methods to teach the marginal math students

AI APPROACH

Students today are taught in much the same way as they were 70 years ago. One teacher cannot be an expert in all subject areas and cannot take the time to evaluate each student's needs.



Expert knowledge transformed into a computer program.

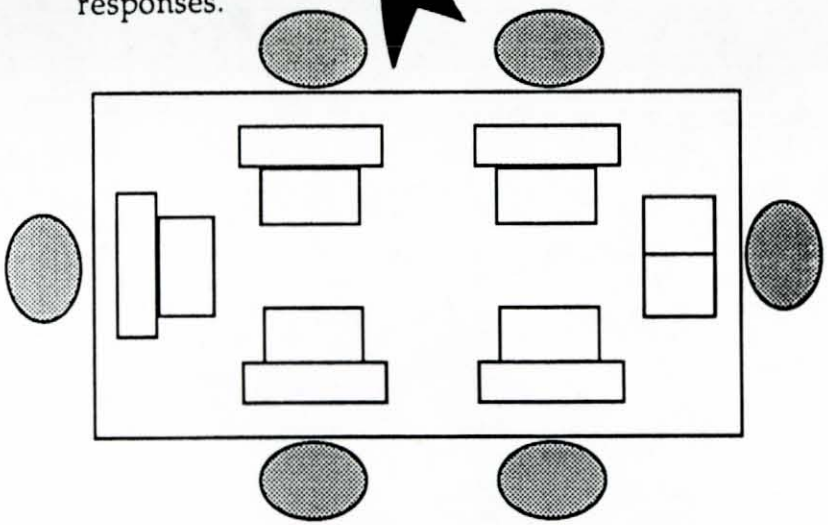
MATH EXPERT

PEDAGOGICAL EXPERT

AI SYSTEM

(2) System pinpoints areas of incomplete knowledge for each student. Recommends pedagogical strategy to address problem.

(1) System evaluates each student's responses.



(3) Teacher adapts medium and methods to meet needs of individual student.

Classroom arrangement encourages interaction.

WHAT IS ARTIFICIAL INTELLIGENCE (AI)?

Artificial Intelligence is the simulation of human cognitive processes such that computer software can reproduce the way in which humans:

(1) Learn (acquire knowledge)
(2) Percieve (intelligent vision)
(3) Reason (problem solving/expert systems)
(4) Communicate (natural language)
(5) Interact with other humans expertly

STATE OF THE ART FOR AI IN EDUCATION

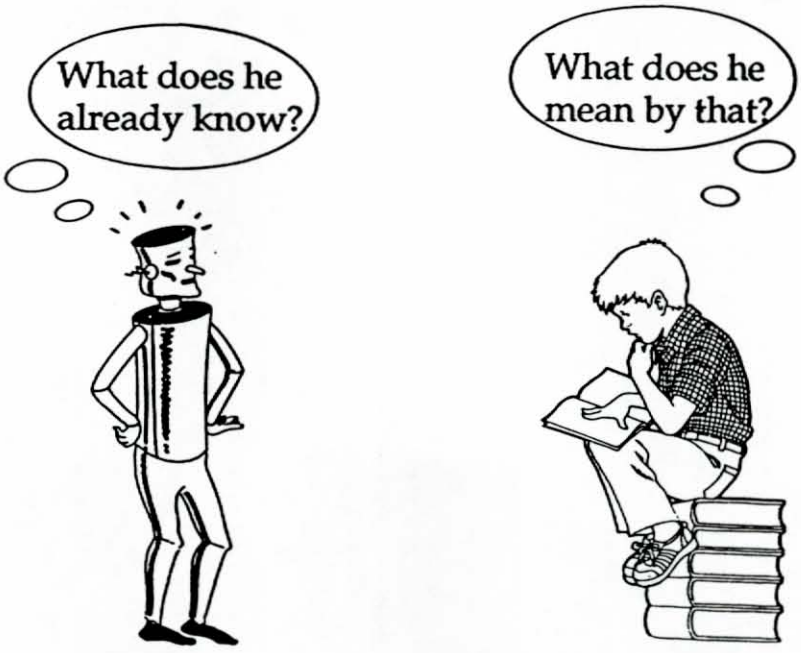
- Numerous prototype systems have been developed as research efforts by Government Agencies primarily D.O.D.
- Only a few systems have been evaluated.
- Most systems have not addressed general education curriculum.
- D.O.D. is currently specifying AI modules in their training system procurements.
- Public educational systems are implementing some computer aided instruction but no intelligent tutoring systems with the exception of research efforts if any.

CURRICULUM DEVELOPMENT AIDS

- AI systems can guide and advise the subject matter expert in the development of courseware/curriculum to improve the affectiveness of communicating knowledge to students.

- Improved curriculum development can have profound effects on how much and how quickly students learn accelerating the process of knowledge acquisition.

AI APPLICATIONS TO EDUCATION CAN HELP ANSWER THESE QUESTIONS



Communicating with the student to transfer knowledge of a domain in such a fashion as to collide with the students existing knowledge. Attaching new knowledge to what exists.

Q: HOW CAN AI HELP IN EDUCATION/TRAINING ?

A: PROVIDE EACH STUDENT WITH HIS OWN PERSONAL TUTOR

- Typical classroom situation involves one instructor and 6-60 students. Instructor cannot address the strengths and weaknesses of each individual.
- Approach a one on one instruction between instructor and student.
- Too few tutors too many students to provide 1:1 ratio.
- Adapt instruction to the peculiar ways that an individual may organize and reason about the domain knowledge.
- Ensure the appropriate application of pedagogical principles. Instructors may not always consistently apply the appropriate pedagogical principles.
- Intelligent tutoring systems don't get tired. The instructor is always available and ready barring any software or hardware problems.

Q: HOW DOES AI HELP THE INSTRUCTOR?

A: This frees up the instructor and allows him to monitor student progress and be alerted to student difficulties such that his interaction with any student is specific to that individuals difficulties. AI can assist the instructor in making the following decisions:

Determining the instructional strategy or tactics to be employed for any given student.

When and how should feedback be presented?

What should feedback consist of in terms of content?

What should be the distance between goals?

How and when should analogy be used?

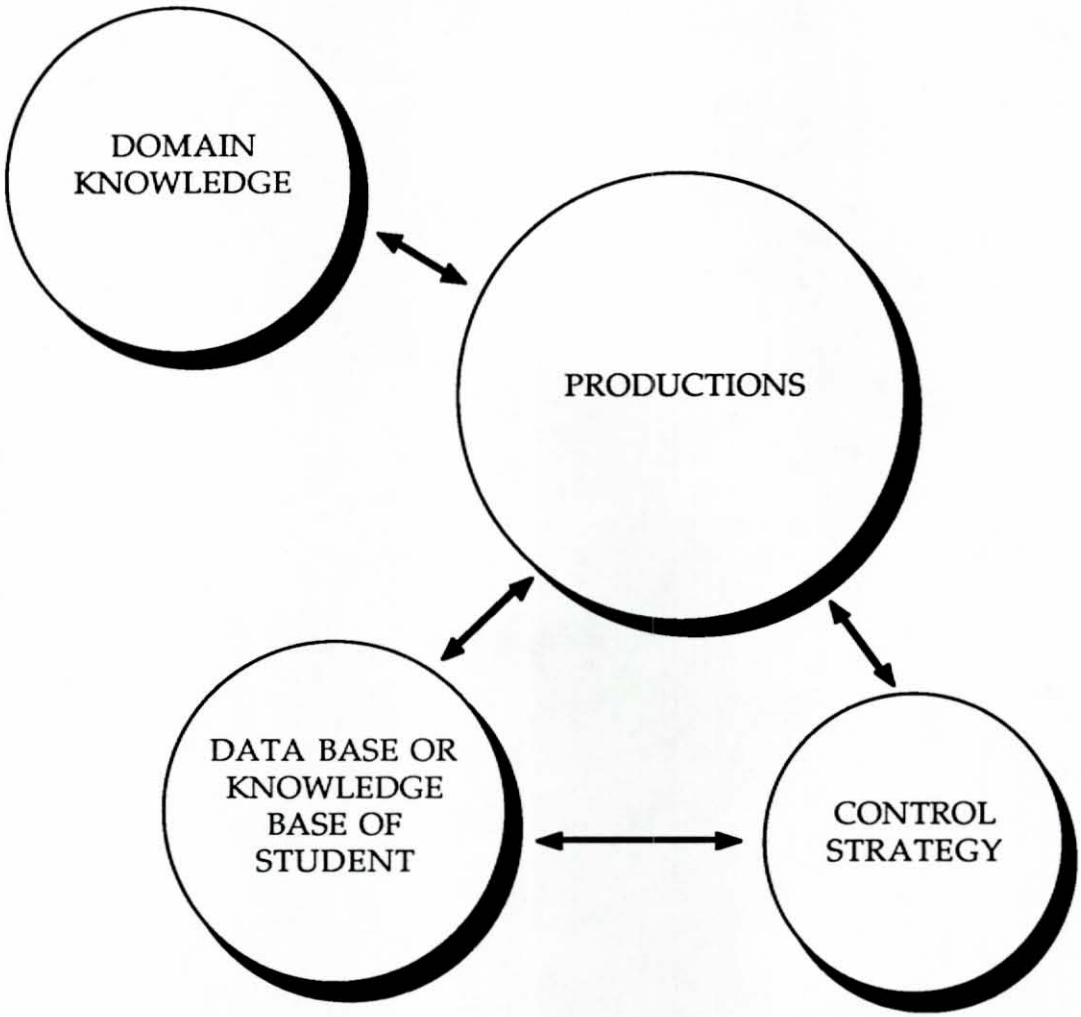
When should student be tested?

How difficult should test be?

When should student be allowed to explore and discover on his own versus when he should be guided?

In what format should information be presented to the student (i.e. Graphic, Animation, Text, Logic, Diagrams etc.)

MODIFIED PRODUCTION SYSTEM FOR EDUCATION APPLICATION



Data Base is Student

Control Strategy is Student Model

Productions consist of rules for governing inferences about the knowledge domain

Domain knowledge consists of knowledge kernels or basic units of knowledge about the subject matter.

DATA BASE IS STUDENT

Objective is to alter student data base so that it is like that of the expert who is modeled in his workstation.

Student consists of all knowledge, experiences, needs, penchants, etc.

CONTROL STRATEGY CONSISTS OF STUDENT MODEL AND PEDAGOGICAL PRINCIPLES

Student model consists of a representation of what the student knows about the domain knowledge. It is built up as a result of system interactions with the student.

Conceptually the student model is compared to domain knowledge to determine

1. If and how student knowledge is incomplete relative to domain knowledge

2. If and how the version of student knowledge is incorrect relative to the version of expert knowledge in the system

Comparisons of student knowledge and system knowledge are diagnostic, indicating what is wrong.

Instructor can then be alerted as to the pedagogical principles which best apply for any given student.

PRODUCTIONS

Productions are the rules which specify how the knowledge of the domain can be put together.

Productions are the logical structures which determine what is a correct legal representation of knowledge and what is not.

In some systems this part may consist of meta knowledge which determines how the content of domain knowledge can be reasoned about.

DOMAIN KNOWLEDGE

This component contains the knowledge structures which define or describe the expertise which is to be communicated to the student.

The manner in which this knowledge is represented determines, to a certain degree, how flexible the system can be in terms of piecing the knowledge together.

The form of knowledge representation also says something about the system designers beliefs about human knowledge representation.

Knowledge representation types may include:
- Semantic Networks
- Schema
- Scripts
- Propositions
- Predicate Calculus
- Frames
- Productions
- Combinations of the Above

WHAT DOES ALL OF THIS MEAN IN TERMS OF WHAT IT CAN DO FOR EDUCATION?

Knowledge structures are the smallest units of information.

Can be used to created a model of expert knowledge.

This model can predict what is correct and what is inconsistent about the way someone understands the knowledge.

Can be used to create a model of how the student represents knowledge to formulate the student model.

Can be used along with other inferencing processes to reason about the domain knowledge.

Since representation is small units of knowledge precise errors in terms of incompleteness can be located.

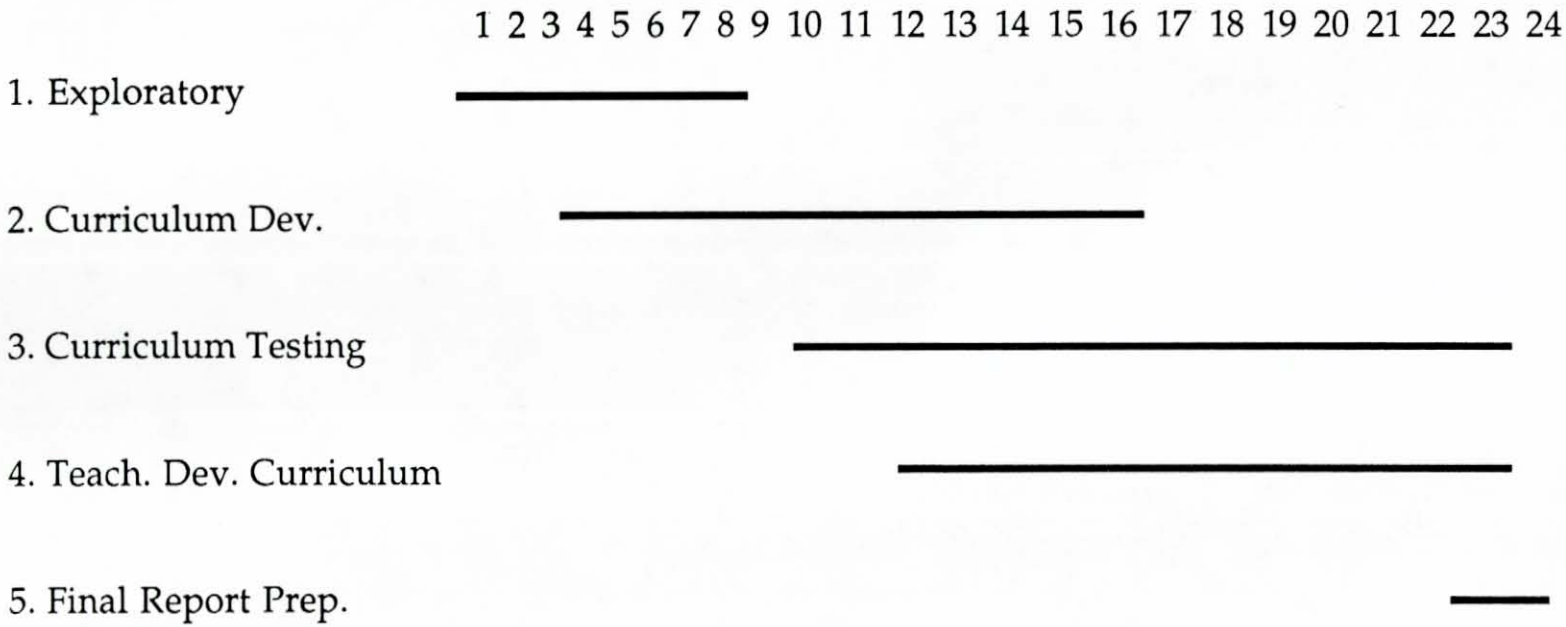
Hypotheses about how the student is reasoning about domain knowledge can be tested to predict student responses in order to determine if student's version of thinking is consistent with knowledge domain.

HOW DOES AN AI APPLICATION TO EDUCATION DIFFER FROM CURRENT CLASSROOM INSTRUCTION

Classroom Instruction	AI application to classroom
Presents fixed sequence of curriculum to all	Adaptive highly flexible sequencing of exercises
Remediation is not individualized	Adaptive remediation branching dependent upon specific needs of individual
Limited diagnosis of student problems	Elaborate diagnostic capability to support development of a student model
Highly structured interaction	Flexible interaction up to robust natural language mixed initiative dialogue
Typically only drill and practice is used as an instructional strategy	Numerous decision processes to determine best pedagogical strategy
Limited information-gain feedback to student otherwise it would take too much time	Dynamic feedback dependent upon student model which involves extensive information gain
Variety of presentation media	Variety of presentation media
Typically encorporates ISD curriculum design approach	Goes beyond ISD to focus upon cognitive level analysis of knowledge
Curriculum centered	Learner centered

SCHEDULE & STAFF

Schedule


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
1. Exploratory
2. Curriculum Dev.
3. Curriculum Testing
4. Teach. Dev. Curriculum
5. Final Report Prep.

- Investigators

  Research and Applied Education Specialists
  Cognitive Psychologists
  Computer Scientists
  Graduate and Undergraduate Education Majors
  Consultants

EDUCATION STAFF

- Supervisor or coordinator of curricula development and experimental programs
  - Must have Ph.D. with experience in researching locus of control and test anxiety programs as well as classroom teaching.

- Statistician
  - 25% of time

- County math supervisor
  - Must have M.S./M.A. or Ph.D degree

- Curriculum specialist
  - Must have M.S./M.A. or Ph.D. degree

- Two math teachers
  - Must have M.S./M.A. or Ph. D. degree

- Reading specialist
  - Must have M.S./M.A. or Ph.D. degree

- Media Specialist
  - Must have M.S./M.A. or Ph.D. degree

PROPOSED
EDUCATION ADVISORY BOARD

- Dr. Allen Schmieder, Chief, Title II of EESA
- Dr. Walter Steidle, Division Chief, Title II of EESA and Chapter 2
- Dr. Seymour Sarason, Test Author
- Dr. Nowicki, Test Author
- AI Expert
- Superintendent of Orange County Schools
- Dr. Arvin Blome, Assistant Commissioner for Colorado Department of Education and Title II of EESA
- Dr. Gary Allen, Development Consultant of the American Indian Heritage Foundation
- Dr. Eddie Anderson, NASA Eduational Division

STAFF

2 - Cognitive Psychologists

1 - AI/Computer Scientist

1 - Senior Systems Software Engineer

3 - Computer Science Graduate Students

1 - Secretarial/Clerical/Administrative Assistant

PRINCIPLE INVESTIGATORS

Kent E. Williams Ph.D.
Research Manager
Institute for Simulation and Training
The University of Central Florida
Orlando, FL 32820

EDUCATION:

M.A. General Experimental Psychology/Neurobehavioural
Connecticut College, New London, CT 1971
Ph.D. Cognitive Psychology/Human Information Processing
The University of Connecticut, Storrs, CT 1976

EMPLOYMENT EXPERIENCE:

June 1986 - Present

Research Manager for Institute For Simulation and Training:

Contract with Cognitive Science Program, office of Naval Research, $356K. This research involved the development and evaluation of an intelligent tutoring system based upon a cognitive model of knowledge acquisition.

Program Manager for Embedded Training Technology Identification and Development:

This effort is ongoing and has cumulatively totaled $546K over the past 3 years. The effort involves the identification and software development of Artificial Intelligence techniques to be evaluated and applied to operator training devices in a multi-threat surface warfare tactical training environment. Sponsored by NTSC code 712.

Program manager for indefinite quantities contract with the Naval Training Systems Center:

Research has included: the development of intelligent adversaries for simulation scenarios; simulating team members and providing expository feedback based upon a software model of an expert tactician monitoring automatically the student's performance; the development of an adaptive instruction capability; team training performance assessment and the development of software for authoring exercises for tactical simulation. Consecutive yearly funding of 480K.

User Computer Interfaces for Computer-Aided Instruction:

This project was awarded by Battelle Memorial Institute to evaluate human factors characteristics for designing interfaces as applied to computer-aided instruction. Contract value of 25K.

Pedagogical Principles for Human and Machine Tutors:

This project was awarded by Battelle Memorial Institute to develop pedagogical principles based upon basic empirical research in motivation and human learning. Contract value of 32K.

Classroom of the Future:

This grant was awarded by the Florida High Technology Commission to develop both a functional specification and an engineering specification for a high technology research laboratory focusing upon the communication of knowledge in an educational or training setting.

1982 - June 1986

Vice President of Advanced Concept Development for Ship Analytics, Inc.:

Responsibilities included proposal preparation and technical management of a number of projects involving advanced training technology, simulation and expert systems.

- Managed the design and development of The Surface Warfare Advanced Training Technology with a contract value of $2.8 million sponsored by NTSC.

- Developed an expert system and natural language interface with Dr. Mallory Selfridge of the University of Connecticut for managing fuel consumption within the U.S. flag fleet with a contract value of $328K, sponsored by the United States Maritime Administration.

- Developed advanced concept design for applying artificial intelligence techniques to provide interpretive feedback, intelligent platforms and adaptive planning of training exercises for tactical decision making trainers; sponsored by NTSC, value $50K.

- Member of proposal preparation team for response to RFP's for design and development of 14A12 ASW Tactical Team Trainer and the Landing Craft Air Cushion (LCAC) simulator based trainer.

- Managed the technical development of an Interactive Video Disc training device for the AN/BQQ-5 Sonar Set. A Training Effectiveness Evaluation (TEE) was also conducted at the FLEASWTRACEN, San Diego. Sponsored by NTEC code 113, contract value in May of 1986 was approximately $2 million.

- Wrote and managed the development of the Command Tactical Trainer Military Characteristics for NTEC Surface Analysis Group, Code 254, with contract value of $79K

1978 - 1982

Director Mara-Time Marine Services which merged with Eclectech Associates in 1981 to form Ship Analytics, Inc. Responsibilities as director of Mara-Time Marine Services included management of 35 technical personnel specializing in the field of psychology and

computer sciences. Duties included managing the Computer Aided Operations Research Facility (CAORF), The U.S. Merchant Marine Academy, Kings Pt., New York. Was responsible for the planning of government research as well as industry supported research for CAORF. Actively participated in the design, conduct, analysis and formal reporting of all research activities. Topics included simulator fidelity requirements for the visual scene, hydrodynamics and man-machine control interfaces for training individuals with diverse input characteristics from cadets through to masters and pilots. A variety of studies in the project areas of displays and instrumentation, equipment layout, bridge systems, perception, performance enhancement, information processing and decision making, navigation planning, watch standing, port and waterway development, and coning and piloting were conducted under my direction at CAORF (contract value 2.7 million per year). Acquired extensive knowledge concerning simulation technology for training and operations research both nationally and internationally. Conducted marketing activities for CAORF and negotiated industry supported contracts relating to CAORF facility use. Since CAORF was a new state of the art simulation facility for an industry which was skeptical, considerable interaction and communication with industry personnel was required to promote its use and develop an international reputation.

June 1976 - February 1978

Experimental Psychologist, Grumman Aerospace Corp.

Responsibilities included the design and conduct of human factors research for GAC under contract to the Maritime Administration, Dept. of Commerce at CAORF, Kings Pt., New York. Research was primarily involved with the evaluation of a variety of computerized collision avoidance systems for vessel safety and productivity employing a full mission simulation facility to conduct the research.

Summers of 1970, 71, 72 & 73

Engineering Psychologist, Naval Underwater Systems Center,
New London, CT.

Temporary employment during the summer months of graduate career. Activities involved writing computer programs to simulate a Sonar DIMUS display. This simulation program was used to generate display images which were assessed in terms of their impact upon human perception and the performance of human operators in the recognition of hits and false alarms in the target detection process. Wrote numerous statistical analysis programs for a variety of experimental designs in FORTRAN IV. Also conducted research to assess human performance reliability in the conduct of fault localization and repair of the AN/BQR-2, BQS-4 ISOT.

TEACHING EXPERIENCE:

1984 Adjunct Professor of Psychology
Course: Theories and Models of Artificial Intelligence, Cognition and Decision making.
Connecticut College, New London, CT

1974-1976 Adjunct Professor of Psychology
Courses: Cognitive Psychology, Introductory Psychology, Behavioral Pathology, Theories of Personality.
The University of New Haven and Connecticut College, New London, CT.

1969-1971 Teaching Assistant
Course: Introductory Psychology
Connecticut College, New London, CT

PROFESSIONAL SOCIETIES:

American Association for Artificial Intelligence
American Psychological Association

Software Psychology Society
Human Factors Society
American Defense Preparedness Association
Society for Computer Simulation

DISTINCTION:

Member National Academy of Sciences Group A3B06
Simulation and Measurement of Human Performance 1979 - present.
Member State of Florida High Tech Committee Evaluation Team 1987 - present.

TECHNICAL SKILLS:

Cognitive Psychology/Human Learning and Memory
Artificial Intelligence Techniques and Knowledge Engineering
Advanced Statistical Techniques Univariate and Multivariate
Programming FORTRAN (extensive), LISP (limited), Interlisp and Franz Lisp dialects
Operations Research
Training Systems Analysis and Design
Perception
Physiological Psychology
Human Factors/Ergonomics
Human Computer Interfaces

TECHNICAL INTERESTS:

Cognitive Simulation Models
Domain-independent Control Strategies/Heuristics
Student Modeling/Intelligent Training Systems
Acquisition of Cognitive Skills
Knowledge Acquisition
Knowledge Representation
Interactive Graphics
Human - Computer - Interface
Simulator based training systems
Machine learning
Human motivation

PUBLICATIONS AND COMMUNICATIONS:

Most of the publications listed have been associated with presentations at industry conferences nationally and internationally.

Williams, K. E., and Reynolds, R. E. The Acquisition of Cognitive Simulation Models. A Knowledge Based Training Approach. In Fishwick and Mojeski (Eds.) Knowledge-Based Simulation: Methodology and Application. Springer-Verlag, 1989 in press.

Williams, K.E., Hamel, C.J., and Shrestha, L.B. An Evaluation of Characteristics Contributing Towards Ease of User-Computer Interface in A Computer Aided Instruction Exercise. NAVTRASYSCEN Technical Report: NTSC TR 88-030, 1988.

Williams, K.E., Hamel, C.J., and Shrestha, L.B. Handbook for Evaluating User-Computer Interfaces for Computer Aided Instruction. Technical Report: NTSC TR 88-033, 1988.

Williams, K.E. and Lang, Sheau-Dong. Artificial Intelligence for Embedded Training Environments. Proceedings from the Society of Computer Simulation, Orlando, FL., April 1988.

Williams, K.E. and Lang, Sheau-Dong. Artificial Intelligence for Embedded Training Environments. Proceedings of the Florida Artificial Intelligence Research Symposium. Orlando, FL May 1988.

Reynolds, R.E. and Williams, K.E. Instructional Technologies for Embedded Training. Proceedings of the Ninth Interservice Industry Training Systems Conference. November 30 - December 2, 1987. Washington, D.C.

Williams, K.E. Knowledge Engineering an Expert System for Energy Management. Fleet Management Technology, 1986. United States Maritime Administration, Boston, MA.

Williams, K.E. Applications of Artificial Intelligence to Tactical Decision making Training. 4th Annual Workshop on

Command and Control Decision Aiding. 4-6 November 1986, Wright - Patterson Air Force Base, Dayton, Ohio.

Williams, K.E. Embedded Training Instructional Technology Identification. Naval Training System Center, Orlando, FL, Sept. 1986.

Williams, K.E. The Architecture of Expert Systems. International Conference on Computer Aided Design, Manufacture and Operation. Washington DC, Sept 16-19, 1986.

Williams, K.E., Reynolds, R.E. and Salas, E. The Interaction of Surface Warfare Simulation with Instructional Training Technology. Eastern Simulation Conference, Virginia, March 3-8, 1985.

Williams, K.E. and Harold, L. AN/BQQ-5 Interactive Video Disc Training Effectiveness Evaluation. Naval Training System Center, Orlando, Florida, Contract #N61339-83-D-0014, July 1985.

Williams, K.E., Henry, W. and Pittsley, V. The Application of Production Rule Systems to Tactical Decision making Training. Report #89-U-206, Naval Training Equipment Center, Orlando, Florida, March 1984.

Williams, K.E., Henry, W. and Pittsley, V. Improved Tactical Performance through the Development of Team Member Expectation Employing a Simulated Team. Report #N61339-83-M-1025. Naval Training Equipment Center, Orlando, Florida, May 1984.

Williams, K.E., Reynolds, R.E. and Salas, E. The Application of Advanced Technology to Surface Warfare Training. Sixth Interservice/Industry Training Equipment Conference and Exhibition, Washington, D.C., October 22-24, 1984.

Williams, K.E. and Kayten, P.J. Equivalency of Simulator Exercises to Real World Experience in Meeting IMCO Training Standards. Eighth Psychology in the DOD Symposium. U.S. Air Force Academy, Colorado, April 21-23, 1982.

D'Amico, A. and Williams, K.E. The Effect of Flashing Patterns on Navigating Channel Bends. American Psychological Association, August 26, 1981, Los Angeles, California. Vehicular Control Processes.

Williams, K.E. and Nieri, D. Coal Management Employing Full Scale Ship Handling Simulation. School of Engineering Old Dominion University and the U.S. Army Corps of Engineers. Dredging Technology: A Vital Role in Port Development. August 26-27, 1981.

Williams, K.E., Taylor, H. and and Buchanon, D. The Application of Bridge Simulation for the Training of Tugboat Operations: A development Program. Proceedings of the International Symposium on Ship Operations, November 17-19, 1981, New York, New York.

Williams, K.E. and Nieri, D. Passage Planning: An objective Assessment of a Bridge Management Procedure vs. Integrated Electronic Aids. Fourth CAORF Symposium, Kings Pt., New York, June 1980.

Williams, K.E. The Human Factor in Steering. International Symposium on Automated Steering. June 21-23, 1980. Genoa, Italy.

Williams, K.E. Mariner Perception of Yaw, Yaw Rate and Bearing as a Function of Ship Size and Mariner Experience. Proceedings of the International Symposium on Ship Operations, October 1980, New York, New York.

Hammell, T., Williams, K.E. and Grasso, J.A. The Role of Simulation in the Marine Training and Licensing Process. National Technical Information Service, Volume I, 1980, United States Coast Guard and the U.S. Maritime Administration.

Hammell, T., Williams, K.E. and Grasso, J.A. The Role of Simulation in the Marine Training and Licensing Process. National Technical Information Service, Volume II, 1980, United States Coast Guard and the U.S. Maritime Administration.

Hammell, T., Williams, K.E. and Grasso, J.A. The Role of Simulation in the Marine Training and Licensing Process. National Technical Information Service, Volume III, 1980, United States Coast Guard and the U.S. Maritime Administration.

Williams, K.E. Validation of Valdez Operational Exercises Employing a Backward Transfer Methodology. Proceedings of the Fourth Annual CAORF Symposium, Kings Pt., New York, 1980.

Hammell, T.J., Williams, K.E., and Gynther, J. Simulators for Mariner Training and Licensing: Phase 3 Investigation of Horizontal Field of View Requirements for Simulator Based Training of Maritime Cadets. National Technical Information Service #8009, U.S. Maritime Administration, 1980.

Williams, K.W., D'Amico, A. and Dinapoli, R. Simulators for Marine Training and Licensing. Phase 3 - Simulator Subsystem Characteristics and Performance Standards for Master Level Simulator Training. National Technical Information Service #8007, U.S. Maritime Administration, 1980.

Williams, K.E. and Keyes, P. Application of Precision Navigation Systems in Sandy Hook Channel under conditions of Degraded Aids-to-Navigation. National Technical Information Service, U.S. Maritime Administration, 1980.

Williams, K.E. and Goldberg, J. Standards of Watch Officer Performance and Collision Avoidance Problem Solving. National Technical Information Service. U.S. Maritime Administration Project #7908, 1980.

Williams, K.E., and D'Amico, A. The Effectiveness of Active vs. Passive Trainee Participation and Segmented vs. Integrated Training Structure on the Acquisition of Shiphandling Skills. National Technical Information Service, U.S. Maritime Administration, #7918, 1980.

Williams, K.E., D'Amico, A., and Goldberg, J. Transfer of Training from Low to High Fidelity Shiphandling Simulators.

National Technical Information Service, U.S. Maritime Administration, #7919, 1980.

Williams, K.E. The Effect of Display Mode Presentation on Computerized Collision Avoidance Decision Making. Summer Computer Simulation Conference, 1979, Chicago, Illinois.

Williams, K.E. Evaluation of the Effectiveness of Valdez Operational Exercises Training Employing Simulation. First Symposium on the Human Element in the Merchant Marine, U.S. Maritime Academy, Kings Pt., New York, October 1979.

Williams, K.E. A Forecast of Training. Proceedings of the Third Annual CAORF Symposium, Kings Pt., New York, 1979.

Williams, D.E. and Gilder, M. Perceptual sensitivity of Masters and Pilots to Bearing, Yaw Velocity and Change of Rate of Yaw as a Function of Ship Size. Maritime Administration, Dept. of Commerce, U.S.A. National Maritime Research Center/CAORF, Kings Pt., New York, 1979.

McIlroy, W. and Williams, K.E. A Controlled Experiment of Mechanical Failures During VLCC Passage Through Valdez Narrows. Marine Traffic Symposium, Liverpool, England, April 3-6, 1978.

Williams, K.E., McIlroy, W., and Mclean. Man-in-the-Loop Control: Instrumentation and Aids to Navigation, Old and New. New York Metropolitan Section of the Society of Naval Architects and Marine Engineers, Kings Pt., New York, May 11, 1978.

McIlroy, W., Pollack, D.M. and Williams, K.E. CAORF Applications in Maritime Research. First International Conference on Marine Simulation, The College of Nautical Studies, Southampton, England, September 5-8, 1978.

Williams, K.E. Human Factors Considerations in Restricted Waters Ship Control. Proceedings of the Fifth Ship Control Symposium, Annapolis, Maryland, 1978.

Pollack, M. and Williams, K.E. An Experimental Investigation of Collision Avoidance Aiding and Human Performance Using CAORF. Conference on Human Factors in the Design and Operation of Ships, Gothenberg, Sweden, February 7-9, 1977.

Williams, K.E. Human Collision Avoidance Behavior and Uncertainty as a Function of Visibility, Traffic Density and Navigational Aids. First CAORF Symposium, Kings Pt., New York, June 23-24, 1977.

Williams, K.E. Human Collision Avoidance Behavior as a Function of Visibility, Traffic Density, Electronic Aiding and Type of Information Displayed. Proceedings of the Human Factors Society, Twenty-First Annual Meeting, San Francisco, California, October 17-20, 1977.

Williams, K.E. Organization and Temporal Processing in Short and Long-Term Memory. Dissertation Abstracts, The University of Connecticut, Storrs, Connecticut, 1976.

Lamb, J., Kaufman, H. and Williams, K.E. Perceptual Processing of Binary Strings. IEEE Transactions and Reliability. July 1972.

Williams, K.E. The Effect of Cingulate and Hippocampal Lesions on Perseveration. Masters Thesis, Connecticut College, New London, CT 1971.

Julia A. Medin
714 Bear Creek Circle
Winter Springs, Florida 32708
(407) 365-4846 (Home)
(407) 275-2037 (Work)

EDUCATION

Ph.D. American University: Counseling and Education
M.A. George Washington Univ.: Higher Education, Mathematics
B.A. Ohio State University: Mathematics, Education

SUMMARY OF QUALIFICATIONS & EXPERIENCE

- Presently teaching Mathematics in University of Central Florida's College of Education.
- Experienced secondary school mathematics teacher in both honors and basic skills classes, including development of new curriculum.
- Performed research on factors relating to the mathematic achievement of high school students. Have proposed corrective methods for the underachievers.
- Experienced in the development and implementation of effective instructional techniques.
- Have applied psychological and counseling techniques including testing and measurements, family interaction, career counseling and group counseling.
- Appointed by a Department of Education senior administrator to U.S. Department of Education's Title II Steering Committee. Also now serving on a National Society Association committee relating to minority participation in mathematics.
- Have presented papers at both national and international conferences.
- Have conducted research investigations relating to various educational issues.
- Excellent scholastic background including Ph.D. (1985) from American University in Counseling and Education.

EXPERIENCE

ASSISTANT PROFESSOR, University of Central Florida, Orlando, Florida. (1988-present)

Presently teaching mathematics to junior level students in the College of Education. I am also working with the College of Education's Office of Research and grant procurement where I will be seeking to obtain research contracts and grants.

MATHEMATICS TEACHER, Montgomery County Public Schools, Maryland (1973 to 1988)

The Montgomery County Public School System is rated among the highest in the United States. Students here include both very high achievers and low achievers. Was instrumental in developing and implementing new instructional curricula and techniques. Instituted new teaching methodologies. Supervised and directed in-service programs.

Programs developed and used for below average students have direct applicability for adults. These methods could also be extended to industrial and governmental organizations including military personnel.

RESEARCH ENGINEER, Sun Oil Company, Marcus Hook, Pennsylvania

Performed mathematical analyses related to experimental research in the petroleum field. Utilized integral calculus, statistics, probability and curve tracing. Also performed studies and analyzed research results from other investigators.

TAX ANALYST, Wilmington Trust Company, Wilmington, Delaware

Analyzed and projected stock trends and assessed the results of investments by major investors.

HONORS

Who's Who in International Education
Who's Who in Human Relations
Phi Delta Kappa (Honorary Education Society)
Academic scholarship from the Ohio State University
Research Grant and assistantship from American University
Graduated from American University with honors (3.9 GPA)

PROFESSIONAL AFFILIATION

National Council of Teachers of Mathematics
The Mathematical Association of America
American Association of Counseling and Development
Maryland State Teachers of Mathematics Association
Women & Mathematics in Education
Association of Teacher Educators

COMMITTEE MEMBERSHIPS

Steering Committee for US Department of Education
Committee plans and officiates annual meeting of Title II. The six geographic regions of the United States each send two representatives to this steering committee.

International Commission for the Study and Improvement of the Teaching of Mathematics (CIEAEM)
Representatives from 30 countries are involved in how to increase the effectiveness of mathematics teaching.

Mathematical Association of America
Participating member of committee concerned with enticing and retaining minorities in higher mathematics courses.

PUBLICATIONS, PRESENTATIONS AND RESEARCH INVESTIGATIONS

A Study of Factors Relating to the Achievement of Marginal Students, Presented and Published by the International Commission for the Study and Improvement of Mathematics Students (CIEAEM), University of Southhampton, England, July 1986

Invitation to be a Presenter at the International Conference on Mathematics Education (ICME) in Budapest, Hungary, August 1988

Behavioral characteristics of marginal mathematics students leading to the design and development of teaching techniques effective in teaching these students. (Ph.D. Dissertation)

Presider at the National Council of Teachers of Mathematics

Presenter at the National Science Teachers Association

Developmental (remedial) programs of US community colleges

Economic feasibility of undergraduate US Schools of Education

Women in educational, administrative and managerial roles.

Successes and failures of mixed marriages/mixed families.

The transfer of American technology (sensitive material) to other countries.

American versus foreign students in scientific graduate programs in American universities.

Researched policy issues relating to ITARS, Title IX, Title II

A Study of Factors Relating to the poor academic performanceof math students -- ICME 6, Theme Group 7

A Study of Factors Relating to the Achievement of marginal mathematics students - Mathematics for those between 14 and 17, is it really necessary? The Cotsworld Press, Eynsham, Oxford, England. Edited by Peter Bowie, 1987.

PERSONAL DATA

Excellent health
Married, four children
Interests: Tennis, travel, music, civic activities

IST BACKGROUND

Formation of IST

The Institute for Simulation and Training (IST) was formed in 1982 in response to the need to build a community of skilled professionals and focus resources on generic research and development in simulation and training. IST is charged with the development of basic and applied research programs in state-of-the-art simulation and training devices and programs. IST is also responsible for identifying the direction of simulation and training technology during the next decade.

IST is a multidisciplinary organization which draws on faculty expertise, the academic resources of the University, and the technical resources of a wide variety of academic, government, and industrial affiliates. These organizations rely heavily upon simulation and training technology including such areas as instructional systems development, human factors engineering, artificial intelligence, computer-aided instruction, computer-generated imagery, and war gaming, among others.

Location

IST is located in the Central Florida Research Park adjacent to The University of Central Florida, east of Orlando. Facilities include 21,000 square feet of laboratory and office space in the Park's Research Pavilion. The Institute's proximity to the Naval Training Systems Center (NTSC), the Army's Project Manager for Training Devices (PM TRADE), the Defense Training and Performance Data Center (TPDC), and related industry, provides a close working relationship with key organizations involved in the simulation and training field.

Mission

The mission of IST is to become the nationally recognized center for research and education in simulation and training technologies.

To develop an operating strategy, a number of factors were considered when analyzing the simulation and training research domains. These factors include:

- Identifying and categorizing those technologies which describe the field of simulation and training along with their associated scientific disciplines.
- Identifying currently funded projects and programs under the various technology areas described. (What are the future trends in simulation and training and how do current projects relate to future technology needs?)
- Describing the skills which support technology needs in order to define the personnel resources required to conduct research in simulation and training.
- Determining the kinds of research laboratories or test beds which shall serve as tools to conduct research in the defined technology areas.
- Relating these technology areas and research laboratories to the subsystem of a training system.
- Preparing procedures for transferring technology development to and from research conducted by IST, industry, government, and academe.

The background represented by IST provides the necessary technical expertise to address the major research issues related to simulation and training. This expertise spans many disciplines and provides research capabilities in nearly all key technologies.

Participating Disciplines

Simulation/Stimulation
Computer Science, Computer Engineering, Industrial Engineering, Electrical Engineering, Mechanical Engineering, Mathematical Modeling, and Technical Communications.

Training/Performance
Cognitive Psychology, Experimental Psychology, Human Factors, Industrial Psychology, Computer Science, Instructional Systems, and Technical Communications.

Key Technologies

Training Systems Effectiveness
The assessment of training requirements and needs and the application and evaluation of training technology for real-world systems and training transfer.

User Interface Design
Research on computer-aided instruction, authoring systems, graphical interfaces, console design, human factors issues, and information presentation.

AI/Expert Systems
Research on knowledge engineering, expert systems, decision making aids, natural language interfaces, neural networks, embedded training, intelligent tutoring aids, and adaptive courseware.

Team Training
Research on team training, skill acquisition, distributed decision making, and training data bases.

IST has established a simulator laboratory with SIMNET (Simulator Networking) as the anchor project. The goal of SIMNET research is to provide a realistic battlefield simulation to satisfy the Army's team collective training requirements. This is accomplished by networking large numbers of interactive combat vehicle and aircraft simulators and their supporting elements. Eventually ground troop simulation will be added to the excerise.

The training exercises can be run on pre-selected and programmed worldwide terrain locations . The simulators send information to one another describing their position, appearance, status etc. by means of local area and long haul networks (LAN and LHN). This information is represented on graphics screens in the vehicles showing views of the battlefield. The crews of the simulators react to their respective views of the action, thereby generating new action and new data transmission.

The SIMNET M1 simulator has a number of systems that logistically or operationally limit the vehicle in much the same way that real-world conditions limit the M1 tank. These systems take into account such factors as M1 armor protection limitations, fuel capacity and consumption, basic ammunition loads and expended ammunition, vehicle speeds, grade climbing, obstacle crossing ability, and reliability and maintenance of components.

A command control network provides support functions such as resupplying fuel and ammunition, unit maintenance with simulated repair and recovery functions, indirect fire support, close air support, FM radio nets, and personnel services support.

The focus of SIMNET research is on developing the technology to allow combat teams to practice critical combat skills that are too dangerous or even impossible to practice in peacetime. Ultimately this research will be directed toward four areas.

1. Improve collective training.

2. A test bed for training combat and force developments and evaluations in a combined arms setting.

3. A "simulate before you build" weapons acquisition system.

4. A test bed for pre-field testing.

IST's laboratories and test beds are the key to meeting the goals of the Institute. These laboratories cover a variety of research areas and are focused on applications of training and simulation technology. The labs are supported by basic research facilities within the university.

Existing Facilities

Networking Laboratory

This laboratory is built around two SIMNET units provided to the institute by PMTRADE. These tools are used to investigate a number of research areas including alternate networking technology.

Team Training Laboratory

Five state-of-the-art 80386 based computers networked together comprise this PC-based interactive laboratory. This facility is used to develop and evaluate team training techniques and conduct assessments of team training performance and distributed decision making.

Part-Task Trainer Laboratory

This facility is currently comprised of three types of part-task trainers. The Army has provided IST with two TOP GUN and two VIGS units for research purposes. This laboratory also houses a General Aviation Trainer (GAT) modified for research purposes.

NTSC Laboratories

These laboratories, including the Visual Training Research Simulator, are available to IST on a collaborative basis.

Facilities Under Development or Planned

Low-Cost Visual Laboratory

This facility will be used to conduct research on low-cost visual testbeds, hybrid visual systems, advanced complexity visual simulation, and rapidly reconfigurable terrain data bases.
Equipment for this laboratory includes the BBN Systems and Technology Visual System used on SIMNET. This system, along with a data base development system and display devices, will allow research to be performed in all aspects (data base, image generation, and display) of low-cost visual technology. A hybrid visual system will also be in place at IST to conduct research in Photo-Based CGI. An HTM "Black Box" will also be utilized in the low cost visual testbed. Finally, an image processing system is being defined to address problems in rapid data base generation.

Current work in this area has been funded by the Office of Naval Research and the Naval Training Systems Center. The areas of training have been focused upon tactical decision making. A variety of techniques and methods developed from basic research are being implemented in a tactical training test bed for multi-threat warfare eg. ASW, ASUW and AAW. These techniques, developed from research in cognitive science, involve embedding and automating numerous instructor functions.

Research areas include intelligent instructional strategies for customizing excercise sequences, intelligent feedback techniques (which provide direction and correction in case of errors of omission and commission respectively), simulating other team members in the training environment, and intelligent adversaries as targets in a simulated scenario. Scenarios will demonstrate coordinated and non-coordinated tactics among targets.

Other basic research involves developing techniques for evaluation and implementation in the area of machine learning. The research goal in this area, as applied to tactical training, involves development of a software module which can learn by observation and interaction with the student to determine the logic of student's responses. In this way the level of play in the excercises can optimally challenge the student.

In brief, given very little information about the student, the system will learn to abstract information concerning student performance. With this knowledge, scenario events can be modified to adjust the level of play for any trainee. This capability will reduce the current costs of developing knowledge-rich systems which compare student responses to rich knowledge bases describing student behaviors in order to determine student capabilities. The system will be used to automatically abstract knowledge from experts interacting with the trainer and use this expert knowledge as a template against which student performance can be compared.