

## **CLASSIFICATION OF ELECTRONIC CLASSROOMS FOR USE OF INSTRUCTIONAL PROTOCOLS**

William A. Platt Ivor K. Davies James R. McConville  
Stephen J. Guynn Gary Orwig Charles G. Bollmann  
Ron Bower Marvin Smith

### **ABSTRACT**

Recent developments in electronics and computer science have been so dramatic that their incorporation into classroom design has caused the term electronic classroom to come into wide use. The purpose of this paper is to explore basic design and training issues for the electronic classroom and to isolate effective practices where they can be identified from experience in the field. To this end, several training sites were investigated to review the teaching and learning that were taking place. Experienced-Derived models of classroom procedure were developed for each situation. A system of notation was created that captured classroom interaction, media use, and personal control. A design classification was used to formulate protocols that fit each situation. The protocols covered steps needed to implement each strategy by incorporating type and frequency of interaction, information source input, communication patterns, locus of control, and type of feedback. The instructional protocols are sets of operating procedures for instructors to use in planning and executing instruction in electronic classrooms depending on the type of electronic classroom. The protocols were devised as a practical extension of learning theory modified by field experience.

### **ABOUT THE AUTHORS**

Dr. William A. Platt holds a Ph.D. in Instructional System Technology from Indiana University. He is a training consultant to business and government. Dr. Ivor K. Davies is Professor of Education and Instructional Technology at Indiana University. Dr. Stephen Guynn is an Evaluation Specialist with Indianapolis Public School System, Dr. Guynn holds a Ph.D in Instructional Technology from Indiana University. Dr. James R. McConville manages the Training Systems Engineering Department at Loral Defense Systems, Akron. His duties include Research and Development of Advanced Simulation Systems. Dr. McConville holds the Ed.D. in Instructional Technology from Indiana University. Dr. Gary Orwig is Professor of Instructional Systems at University of Central Florida. Dr. Charles G. Bollman is the head of instructional services for the FBI Academy, LTC Ron Bower is operations coordinator for Marine Corps Service Support Schools. Doctoral candidate Marvin Smith teaches air control at Embry Riddle Aeronautical University.

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## INTRODUCTION

### Instructional Needs

Tremendous pressures in the current education and training environment and the need to do more with less financial resource have added to the frustration of the educational community as it seeks effective solutions that appear just out of reach. Over a period of years various "hard" and "soft" technologies have presented hopeful educators with new sets of tools designed to increase the efficiency or effectiveness of the teaching-learning process. The latest of these is the electronic classroom.<sup>1,2,3</sup> Like other technological innovations such as programmed instruction, instructional television, and computer-aided instruction, the concept is marked by mixed results and multiple definitions. This situation has refocused attention toward the reinvention of tools, processes, and values that had been taken for granted as fixed aspects of the educational setting. The classroom which was by in large a product of the industrial age, must now be redefined in terms of the information age. The following definition was used to guide an investigation of several electronic classroom sites involved in either research or the delivery of instructional programs.

### Definition of The Electronic Classroom

An electronic classroom is a computer-supported classroom designed to facilitate student learning by enhancing the

interactivity between students and subject matter through the use of electronic media.

There has been a fundamental shift in vision that goes with this new definition of the classroom with the learner elevated to a position of greater prominence. New organizational structures and new practices are emerging to fill the space created as our culture copes with a period of transition. Several principles underscore the changing situation: (1) Classroom organization will be designed around the student not the teacher. (2) Learners will do more of the work of instruction. (3) More instructional decisionmaking will be in the hands of the students. (4) Students will perform whole tasks and integrate their learning to work situations rather than study isolated fragments fed to them by the teacher. (5) the organizational structure of the teaching learning hierarchy will become flatter and broader. And (6) Computers will become the central tool of the classroom. This last point is perhaps the most visible characteristic of the design changes being considered for electronic classrooms. Computers will have three uses: (1) control of media at the instructor console, (2) delivery of individualized or group instruction, and (3) response evaluation and retention of instructional knowledge in so-called "smart systems." All of this will be marked by greater interactivity in both instructional strategy extremes -- that is, group lecture on the one hand and individualized self study on the other.

### **Purpose**

The purpose of this paper is to provide benchmarks to help determine electronic classroom design and employment strategy in actual teaching and research settings. Several field sites were studied. The sites were chosen not as examples of perfect solutions, but as locations where the leadership was committed to meeting the challenge of classroom redesign. A conceptual framework was used to capture the range of use and to classify the design of electronic classrooms. Each cell of the classification matrix represented a potentially different challenge. A protocol model and notation system was used as a means to capture the critical success factors needed for each of the situations found in the field. To this end a protocol model was created. The protocols provide rules that will optimize interactivity of the instructional delivery process to increase classroom learning in a predictable way.

### **Reinvention of the Classroom**

The transition period will last for several years with both traditional and experimental solutions existing side by side. Traditional academic classes are marked by an implicit assumption that learning is spread over an extended period involving study, homework, and gradual change in behavior. The academic model is, however, less attractive to the military which places great emphasis on learning during the instructional period. To military instructors it makes sense to have learning take place while they are able to guide it and to observe progress. Focusing on the classroom as a location for learning has stimulated the use of technology and the role of the student and the instructor in classroom learning. Some technology is focused at reducing the workload of instructors, while other technology is focused on giving them more control. The

role of the student is not always the same in each situation. Different degrees of interactivity are appropriate at different times and for different subjects. Without a specific design and clear training objective, these issues can not be resolved. Therefore a central theme of this paper will be to resolve these issues at the protocol level.

### **Instructional Protocols as a Function of Electronic Technology**

At least ten to fifteen years of experience with electronic media have produced considerable data on what works and what does not. That experience must be translated into models of value to the practitioner in the field. The heart of the matter is the formulation of training strategy that builds upon behavioral science and is specifically designed to take advantage of the functional capability of current electronic technology. Electronic media present a large array of functional possibilities, but it is the educational value of the individual medium that must be identified and codified in practice.

### **Design Issues**

There are design issues which are best treated in specific situations. These include: (1) type of computer architecture, (2) instructor control versus student control, (3) contingent behavior and learner reinforcement, (4) type of courseware, (5) the use of authoring systems, and (6) the degree of interactivity and feedback. These issues represent design problems that have great potential to effect the critical success factors identified in each protocol.

## **CLASSIFICATION FRAMEWORK**

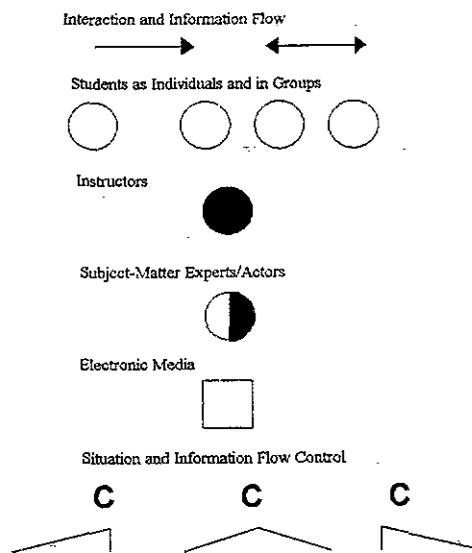
It is important that a classification that will be used in a period of transition presents a framework that includes elements of both the

past and the future. Three issues bridge the gradual shift in emphasis over time. These then provide three critical dimensions of design: (1) presentation mode, (2) generality of purpose, and (3) degree of conferencing capability. Figure 1 identifies the logical possibilities based on these three characteristics. Theater and carrel modes refer to the source of the information being presented to the learners. In theater mode all attention is directed to the front of the room. In carrel mode each student has an information source at a student station. Some classrooms are set up with both and are, therefore, mixed mode. Classrooms are also either dedicated to a specific function or are open for general use. Dedicated instructional classrooms such as simulation laboratories often present special problems to the instructor and student. These problems must be addressed in the instructional strategy in use. General purpose classrooms offer the possibility of transferring effective instructional technique from one class to another. Protocols should reflect this difference. Classrooms also differ in conferencing capability. As used here conferencing refers to any means of interactive electronic communication. Examples are the networking found in distance education, simple intercoms, responder systems, and interactive bulletin boards using computers. Conferencing generally implies two-way communication, but one-way response systems are included under the concept used in this classification. By categorizing classrooms as to presentation mode and generality of use, a matrix of six cells was created. Each of the cells can in turn be classified as having or not having conferencing capabilities for students to interact with each other or the instructor,

both inside and outside of the room. A system of notation can capture other aspects of the instructional setting within each of the cells of the matrix.

### INSTRUCTIONAL NOTATION

A simple notation was created to depict the source of information, the nature of the interactivity the players involved, and the control of the situation. Appendix A depicts the classroom design for each of the field settings. Notation has been added to diagram the teaching learning situation in each of the classrooms depicted. The notation has also been added to each of the field descriptions below. The notation includes symbols for teachers, students, subject-matter experts / actors, communication flow, electronic media, and control. The symbolic representation is as follows:



	Multiple Use		Dedicated Use	
Theater Mode	Conf	Non-Conf	Conf	Non-Conf
Carrel Mode	Conf	Non-Conf	Conf	Non-Conf
Mixed Mode	Conf	Non-Conf	Conf	Non-Conf

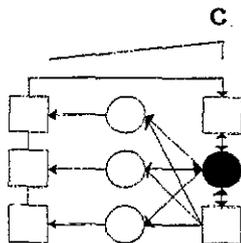
Figure 1 Classroom Matrix

## EXPERIENCE AT THE SITES

Differences in usage and design were found in the field settings. The seven sites were however, all actively looking for new ways to improve instruction. Each site was investigated to review the use of classroom technology and to identify problems that have forced designers to cope with the instructional delivery problem in different ways. Where possible, critical success factors were identified.

### FBI Academy

One of the earliest full scale attempts to increase the use of technology in the classroom occurred at the FBI academy at Quantico, VA. Classrooms featured a response system, rear screen and front screen projection, and networked video distributed on call from a central point to classrooms. The student and instructor stations are depicted in Appendix A. The instructional control and interaction is depicted as follows:

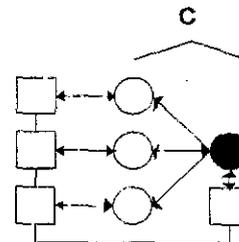


Much has been learned as a result of years of experience. The importance of training

instructors to operate the equipment was learned in regard to the responder system. The use of responder systems also was found to be dependent upon greater instructor preparation time. Use of the responder system for testing proved impractical because of the level of technology which was available when the system was installed in 1972.

### Marine Corps Base Camp Lejeune MCSSS

One innovative use of computers in electronic classrooms is at the Marine Corps Service Support School, Camp Lejeune, NC. Stimulated by the need to train financial managers to use computers, classrooms were designed with networked computers at each student position. The instructional interaction and control is depicted as follows:

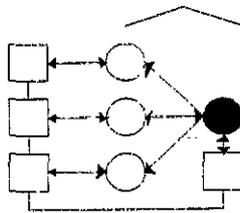


Instructors found that in addition to teaching students how to use the computers, the computers also offered a means of delivering a wide variety of instruction. By networking monitors and using a single instructor console to generate a signal,

instructors were able to use presentation programs to teach lectures in other schools including Motor Transport, Food Services, Supply, and Administrative schools. Instructors were able to take charge of their own presentation production which resulted in faster updates and individual initiative in presentation design.

**Indiana University**

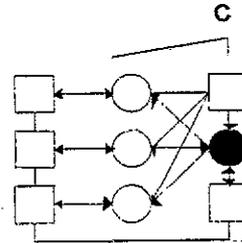
The School of Education in conjunction with the Division of Instructional Technology conducted experimentation in the 1970s with a classroom that had centralized control at an instructor console, rear screen, mobile use of TV and video taping, rear screen projection, and a responder system. The school of education has benefited from the early work in classroom design. A new building features networked classrooms including two computer classrooms. One of these is used as an open laboratory, the other as a scheduled classroom. Emphasis has been placed on the learning of computer tool skills to enhance learning in other areas. A wide-area network facilitates data transfer and provides the infrastructure needed to originate distance-education programs. A typical interaction and control configuration is depicted here:



**University of Central Florida**

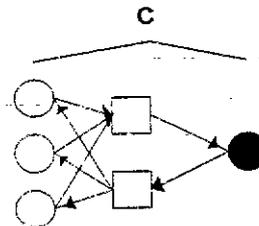
The University of Central Florida and the Institute for Simulation and Training use an electronic classroom to conduct research on the design, development, and delivery of training. Current research topics address the use of artificial intelligence (AI) and expert

systems as tools to facilitate ways to increase local production of individualized instruction. The aim of the research is to make a training system more responsive to the needs of classroom users. A typical configuration follows:



**Indianapolis Public Schools**

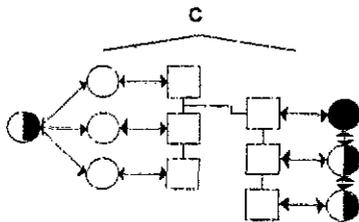
Prototype development is underway to link different settings using interactive electronic technology. The "worlds largest fiber optic cable network" has been established linking three high schools to teachers at Indiana University. High school classrooms are equipped with cameras and large screen TV monitors for two-way television transmission in real time interaction between teachers in one locale and students in another. The configuration is:



**Embry Riddle Aeronautical University**

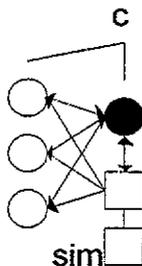
The development of a classroom designed to simulate an air control facility has recently been initiated. This facility uses consoles approximating the new air control consoles in general use. Features have been added to prepare the students for changes in the air control system brought about by recent upgrades to the FAA system. The system is capable of simulating an air control screen and presenting computer-based instructional sequences on the same screen. Live player

simulation inputs are provided by pilots in a separate room equipped to provide the required inputs for voice communication and aircraft flight. Instructors can play the role of aircraft pilots who can interact in real time with the students. Some instructors act as coaches and provide "over the shoulder" help to the students when needed. The configuration follows:



### Loral Corporation

Loral Defense Systems, Akron, OH has undertaken the development of several prototype classrooms that will link classroom instruction with simulators in real time. A demonstration and briefing room is equipped with video projection and multimedia control console at the podium. Loral also has developed simulator suites where computer-based training can be linked to real time simulations. Loral is developing classroom concepts using the technique of "rapid prototyping" in the manner suggested by Tripp and Bichelmeyer. The configuration and interaction diagram is:



### **INSTRUCTIONAL PROTOCOLS**

The protocols are based upon the idea that classroom teaching strategy: (1) should take advantage of the design of the classroom in

which the teaching is taking place, (2) should be aimed at achieving learning objectives by taking advantage of the options offered, and (3) should identify critical success factors that are common to all designs as well as those that are unique to a specific situation. Therefore the protocols are organized as rules for using each of the classroom configurations included in the classification matrix. By focusing on one cell at a time, the clarity of purpose and instructional intent is increased.

### Protocol model

A protocol is a set of instructions that when followed will assure that instruction follows a pattern that has proved effective. The protocol model is divided into components which includes the preparation of instructional material in the format and medium needed for delivery in the electronic classroom. The model used here contains the following components: (1) Preparation, (2) Setup, (3) Delivery and Rehearsal, (4) Interactive Dialogue and Pattern, (5) Control and Evaluation Feedback, (6) Records, and (7) Closure. The key to all of the protocols is the way in which the learner is stimulated to be an active participant in the learning process. In some of the classroom applications a passive learner is more typically the case. For these situations the protocols change emphasis from delivery interaction to preparation of content that is organized to stimulate the learner to engage in active cognitive participation.

### **PROTOCOL EXAMPLE**

The following protocol is identified by the three dimensions of the classification matrix. Each set includes a brief introduction and example that fits the set categories.

### Mixed Mode, Multiple Use, Conference Type

This type electronic classroom is commonly used to present prepared lectures where the participants can work on individual materials during the instructional period and communicate with others inside and outside of the classroom. Presenters design the content to introduce a topic and then let the students practice at their own pace using equipment at the student station. Electronic podiums and response and communication systems are geared to monitor each student and to allow for individual and group communication. The classrooms at the Financial Management School and the Personnel Administration School at Marine Corps Service Support Schools are of this type.

(1) Preparation. Plan the lesson or briefing using learning objectives or briefing points and prepare lesson content materials to support the objectives in presentation order. Particular attention is paid to the structure of the lesson/lecture. Content must be logical and teaching points used to lead into the practice sessions. Plan for classroom assistants to help the instructor. Identify teaching points to focus the attention and alert the audience to possible areas of difficulty with the material. Critical Factor: Lesson material in interactive format must be available at each student station.

(2) Setup. Check the equipment. Ensure that the media work. All items to be used together should be compatible. Ensure that on-line data bases are up and working. Critical Factor: Equipment check-out and testing, compatible hardware and software.

(3) Delivery / Rehearsal. Rehearse the delivery to gage timing and emphasis. Monitor student progress and use student examples to point out problems. Ensure that students are given time to practice correct procedure after making errors. Time the

conference discussions in rehearsal. Research any unanticipated questions. List source references. Prepare follow up points and summary review points. Critical Factor: Timing and sequence.

(4) Interactive Dialogue and Pattern. Note the extent of audience participation in the conference mode, and guide audience interaction by showing examples to the class. Instructors can guide the student practice sessions by individual and group coaching. Critical Factor: Control, motivation and question structure; corrective instruction; practice and reinforcement.

(5) Control and Evaluation Feedback. Overall control rests with the instructor who can take over at any time. Learners have control over the pacing of their individual practice sessions. They can initiate communications to external file servers. Audience/Learner conferencing is moderated by the instructor who notes the quality and accuracy of audience response and provides feedback at the earliest point in the dialogue consistent with courtesy. When the evaluation feedback is provided on a subject that has clear right and wrong responses, rehearse the correct response after providing feedback on the error. Critical Factor: Timing, personal motivation, group norms.

(6) Records. All record keeping is performed jointly by instructor and students. Instructors record audience queries and make electronic notes at the instructor console. Students make entries into logs and records made available by the courseware. Critical Factors: Student awareness of progress in relation to the course outline.

(7) Closure. Summary statements and direction for future study are made by the instructor who includes reference to any unanswered questions that have not been resolved during the class period. Critical Factors: Motivation, planning, concept reinforcement.

### **General and Specific Factors**

Some critical factors can be divided into general and specific. The most consistent finding across field locations was that effective use of electronic classrooms was directly related to instructor training and preparedness. In contrast to this general factor, specific critical factors exist for specific settings and situations. For example the accurate ability to role play the part of a pilot is specific to the dedicated air control classroom.

### **RECOMMENDATIONS**

Recommendations include specific actions and changes in point of view. It is necessary for instructional designers to comprehend the subtle and profound changes occurring as the information age replaces the industrial age. This change brings with it a tremendous opportunity. A new paradigm must replace the old concept of the classroom. Protocols can play a role in making instructor training more consistent and productive. But they are more important as a tool for change when they cause the reexamination of basic assumptions about students and teachers. Increasing the effectiveness of training for the instructional staff is perhaps the area of greatest potential for enhancing the effectiveness of electronic classrooms across all categories of the classification matrix. Protocols can be tailored to enhance the degree of skill and understanding of the instructional staff in applying instructional principles and in using equipment to advantage. Greater focus on the teaching and learning can occur converting an electronic technology into what Davies<sup>5</sup> has referred to as "performance based technology" where real gains can be made.

### **Protocol Design Hypothesis**

This project hypothesized that inquiry into

the history of the several sites would reveal a relationship between learner interactivity and the general success and longevity of the classroom design. In general this idea was supported - with one surprising exception. Interactive response systems (as presently designed) are underused. Several factors that have masked or moderated the relationship between interactivity of the design and the perceived success of the facility were identified. The first of these is the lack of a precise definition of interactivity. Second, is the swamping effect of subject matter organization and presentation over media modality. The third was the functional limitations of early equipment used for responder systems. Fourth, was the teacher training and skill at creating a motivating interactive learning environment.

### **Dedicated Research for In-service Settings**

The field settings studied included some that emphasized pure research and some that carried on day-to-day instruction. Both are needed. One activity generates ideas. The other checks them against the reality of day-to-day practical stress. This latter point cannot be overstated. It is highly recommended that electronic classrooms be tested in actual use. The protocols represent a first attempt to compensate for limitations and to enhance the advantages of real settings by bringing attention to critical success factors. It is expected that protocols for each setting will be modified as they are used as the basis for planning instruction and training instructional staff. The protocols should be treated as a dynamic solution that needs to be continuously refined within each of the cells of the matrix to ensure optimal application.

### **Focus On Teaching and Learning Process**

The point of having protocols is to focus more on the teaching and learning interactions and less on the equipment-oriented aspects of the electronics. Avoidance of future pitfalls for the use of electronic classrooms features will require a less intrusive equipment environment so that teaching and learning can prevail. This will become even more important as the role of data bases and networked resources becomes a more evident factor in instructional technology.

### **Specific Design Recommendations**

Design solutions should promote active learning in an environment that includes *corrective feedback*, *motivation feedback*, and *flexible media* under student control. Responder systems have not worked well in the past but have great potential. The causes of the poor results relate to teacher training, instructional planning, and equipment limitations. It is recommended that interactive response systems be included in future designs, accompanied by adequate training of the instructional staff. Time must also be given to the preparation of the *content materials* for an interactive format. The equipment must be easy to use, reliable, and fast. Future designs should take advantage of advances in computer interactive networking. Multitasking environments will make it possible for students and instructors to engage in a dialogue while other programs (and other students) are performing other learning tasks.

### **Rapid Prototyping**

One very useful practice is recommended for future electronic classroom design efforts aimed at meeting user needs on a timely basis. Rapid prototyping has been used successfully in industry to develop software.

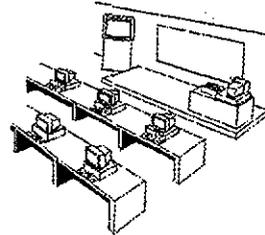
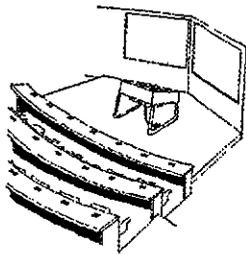
Tripp and Bichelmeyer<sup>6</sup> have pointed out that the concept can be applied to instructional design strategy. Extension to classroom design also seems warranted. The cost and exasperation associated with planning new facility designs could be moderated by this approach, which was one of the methods reviewed by the Oklahoma University Instructional Technology Effectiveness Study.<sup>7</sup>

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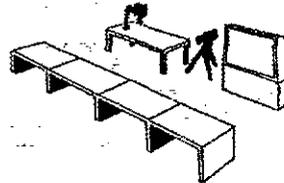
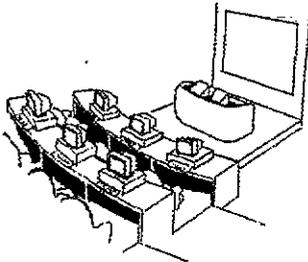
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APPENDIX A  
Electronic Classroom Configurations

Left: FBI Academy: Theater Mode, Multipurpose Use, Conference Type. Right: Marine Corps Service Support Schools and Indiana University: Mixed Mode, Multipurpose Use, Conference Type.



Left: University of Central Florida: Mixed Mode, Multipurpose Use, Non Conference Type. Right: Indianapolis Publid Schools: Theater Mode, Multipurpose Use, Conference Type.



Left: Embry Riddle Aeronautical University: Carrel Mode, Dedicated Use, Conference Type. Right: Lorain Defense Systems Akron: Theater Mode, Multipurpose Use, Non Conference Type.

