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MOVING FROM TWO-WAY CABLE TECHNOLOGY TO EDUCATIONAL INTERACTION--ETC(U)
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MOVING FROM TWO-WAY CABLE TECHNOLOGY TO EDUCATIONAL INTERACTION

This paper deals with the use of simple home data terminals for adult education in Spartanburg, S.C.* The decisions that led to the use of data terminals for adult education and the design of the software to provide educational interaction using an eight-button terminal are reviewed.

Funded by the RANN program of the National Science Foundation, the Spartanburg project is a series of experiments that seek to determine the social benefits of two-way interactive cable television. Based on research designs that compare two-way cable with alternative forms of public service delivery, the project has used cable to train day care center personnel, to teach first aid, and to provide continuing education. Only the adult education activity will be treated here. The focus *will* be *on the man-machine interface: What* human factors were fed into the technical design of the program, and how the technical characteristics have, in turn, affected the process of education.

The substantive content of the project is high school education for adults. Every state has a program that awards a high school equivalency degree for students who pass a standardized test. The test, often called the GED (general educational development), is administered in rotation throughout a state. Some adults simply take the test without any formal preparation, but many first enroll in GED preparatory courses. Such a course has been offered by Spartanburg Technical College (or TEC, as it is called in South Carolina), where a typical course runs for 15 weeks. Three teachers instruct a class in English, math, and reading skills. A class might meet 4 days a week, 3 hours a day, or on a similar, intensive schedule for an approximate total of 180 instructional hours.

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*Views expressed in this paper are the author's own, and are not necessarily shared by Rand or its research sponsors. This paper is prepared for the National Telecommunications Conference, Dallas, Texas, November 29 - December 1, 1976.

During Rand's initial field work in Spartanburg, GED instruction stood out as a choice for a cable application. There is a compelling need for adult education in the area, as 62 percent of the population over 25 years of age lacks a high school education. There was reason to believe that lack of transportation, the need to care for children or relatives, and psychological barriers were preventing many of these students from signing up for conventional classes. Then, too, the content and format of TEC's classes are easily adaptable to cable. GED classes are short term and intensive, and the curriculum is well developed. Finally, the availability of established educational tests, including the GED itself, provide reliable and meaningful ways of evaluating the effectiveness of education over two-way cable.

The decision was therefore made to offer residents in the Spartanburg cable area the opportunity to enroll in a GED course in their own homes. The cable students would have a simple home data terminal, allowing them to interact with the teacher in the cable studio. The project was designed to compare a group of cable students with a matched class taking a conventional GED course at TEC. By careful arrangement of teaching schedules, TEC was able to ensure that the same materials would be covered by the same teachers each day of class. For example, the English teacher would teach the cable students from the studio from 8:30 a.m. to 10:00 a.m., then drive to TEC, and teach the conventional class from 10:30 a.m. to noon. The math teacher would teach the conventional class at 8:30 a.m., and--passing the English teacher going in the opposite direction--drive to the cable studio at 10:00 a.m. to take over the cable class. All students would pay the same enrollment fee and textbook costs, and use the same workbooks. We could evaluate the effectiveness of interactive cable education in the home in direct competition with conventional education while holding many factors constant.

THE TECHNICAL BASE

Having established the research design, we found that we had made several assumptions about the teacher-student interaction that would affect the technical configuration.

(1) Residents of any home in the cable area were potential students.

(2) The students would watch the class on a midband cable channel (for reasons of privacy).

(3) The students would have home data terminals.

(4) The program would be live, with teachers reading a display and responding to the students over the cable channel.

Through the foresight and initiative of The TeleCable Corporation, owner of the Spartanburg cable system, there was already a two-way system available throughout the city. Although the cable system is not a concern here, it should be emphasized that TeleCable had extensive experience with an earlier two-way system in Overland Park, Kansas, and the project received a tremendous boost from the way the Spartanburg system was designed and constructed. Every home in the Spartanburg cable system area could be provided with a two-way capacity, and more than enough channel space was available. Equally important, because of the way the system was constructed, we had hopes that the aggregated signal ingress and other problems that had plagued earlier efforts would not be serious.

A second essential capability was provided by Interactive Systems, Inc. (ISI) of Ann Arbor, Michigan. ISI has a line of on-the-shelf hardware that they have marketed for use with coaxial systems in major manufacturing plants. Most components could be used immediately, and one modem would require only slight modification in order to serve as a student terminal. TeleCable agreed to provide a mini-computer, and ISI responded to our request for bids with an acceptable price for the rest of the hardware. ISI had experience in designing and placing several types of data systems on two-way cable in the field, and we were confident they could do it for us.

The third component was provided by Spartanburg Technical College. As mentioned, TEC already had an ongoing curriculum in high school equivalency education. It had recently revised its curriculum in a way that was quite compatible with televised teaching, and could provide teachers and an administrative structure for the course.

Thus, on July 1, 1975, when the National Science Foundation awarded the basic contract for the study, the technical and organizational problems had been largely resolved. The project would apply existing technology and rely on an existing educational program. There was one pervasive worry about signal ingress and a lot of administrative problems involving delivery dates and the like, but we were largely able to move beyond the technical performance questions. The project concentrated then on the man-machine interface and the functional aspects of the interaction.

THE HUMAN INTERFACE

As many engineers are aware, the package that components fit in can be as important as the components themselves. In the Spartanburg adult education project, we made some very simple decisions about the student terminals that had very little to do with electronics, but that contributed substantially to the success of the adult education project. Some conclusions flowed from the fact that the terminals would be in students' homes. Gaining access to homes for any purpose can be awkward and time consuming, and maintenance and repair would be much more difficult than work in our own facility. Moreover, the students would have no one available to help if they had problems understanding and operating the terminals. Because of these considerations, the terminals had to be both reliable and simple.

Remote Keyboard

In the original ISI design, the electronics for the data terminal are in a single modem. As we began thinking the problem through, we realized that the typical student would have the terminal on a coffee table or folding card table in his livingroom. It would either stay there and be tripped over from time to time, or it would be put away and dropped from time to time. Or both. Neither prospect encouraged us.

As a consequence, the push-buttons were designed into a separate handset. The basic modem, with its heavier power supply and its more fragile electronics, could be tucked safely away under the television set. Moreover, the more vulnerable connection of the modem into the cable system would be protected. Now the student could pick up a light handset at the end of a 15-foot connecting wire and give it reasonable abuse.

The only decision remaining was the number of buttons and how they would be stroked. Although cost would prevent us from providing each student with a full alphanumeric keyboard, we also felt that a complex keyboard would have questionable value from an educational perspective. We felt that it would be difficult to teach students how to use a keyboard with many functional capacities, and that it would be distracting. Instead of concentrating on the coursework, the students would have to concentrate on learning how to use the keyboard. We eliminated the use of multiple-stroke codes for the same reason. For example, a four-button keyboard could offer 16 combinations, but then the student would need to refer to a list of some sort to know what each code meant. Since we wanted the student involvement to be as direct and simple as possible, we felt we had to live with single-stroke codes.

So how many buttons were needed? We considered everything from 2 to 16, and chose 8 as the smallest number that was compatible with prepared educational materials. Review of the written materials that would be used in the equivalency programs quickly indicated that many exercises had five multiple-choice answers for questions in the workbooks. We envisioned the teachers relying heavily on these prepared exercises for student drills and multiple-choice questioning, so unless we wished to reform conventional adult education texts, four buttons was not enough. After the software functions were set up, we found that eight would serve quite well. The availability of low-cost keyboards and other considerations then led to the final handset. It has eight buttons that interlock so only one can be depressed at a time, and an additional "send," or "end of message," button.

This configuration had a fortuitous result for the student. We had worried that the student might need or want some form of confirmation that his signal was received correctly, but the cost of this function led us to decide against it. When we chose to have a separate end-of-message, or send, button with interlocked keys, however, we discovered that we had a primitive form of confirmation built in. The locked-down button is not affected by depressing the send button, and the student can check what he sent by checking his own terminal. The student could not usually correct his answer, but at least he would know the nature of his error if the teacher informed him his response had been incorrect.

We now had a simple terminal in mind with eight possible signals. The challenge was designing the computer software and the teacher activities so that we could come as close as possible to providing the wide and complex array of human communications available in the classroom. We would, of course, lose many facets of the educational interaction available in face-to-face communications. But we could also seek to find functions not available to a classroom teacher that might, in some small way, help compensate for what was being lost.

INTERACTIVE FUNCTIONS

As Rand, TeleCable, ISI, and TEC representatives talked back and forth in the fall of 1975,* it became clear that we needed to provide for interaction beyond multiple-choice questions and answers. The basic decision that increased the flexibility of the student terminals was to set up the system so that the teacher could change the mode of interaction by changing the meaning of signals from the student terminals.

There are of course many types of educational interaction, and we first tried to determine what functions are normally carried out in classroom interaction, and which ones of these would be lost. We found a handle on the problem when we distinguished between those interactions initiated by the teacher and those initiated by students. Then we classified the teacher-initiated interactions into formal and informal. The result was three categories of interaction.

Formal Teacher Initiatives

The most formal interaction in the classroom is the written quiz. The teacher poses a series of questions for the class, and they write the answers they believe to be correct. In giving a quiz, the teacher is forcing each student to confront what he does and does not know, gathering data for the purpose of grades, and, at the same time,

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*While many helped in this effort, Gordon Herring of TeleCable, Harold Katz of ISI, and Jocelle Heatherly of TEC were the key points of contact, and they each made a unique contribution.

obtaining a diagnostic about student weaknesses. The classroom teacher also performs this function when he asks the class whether they know the answer to a question, and then calls on one or more students to determine whether they do. The student again has to ask himself what he knows and, over time, the teacher gains information about student progress.

This form of interaction fits in quite well with the use of data terminals. With the system in place in Spartanburg, the teacher puts the system into "Q" mode, and asks a formal question. The multiple-choice answers will be displayed over the cable, or the teacher will refer to an exercise in their workbooks. After a pause, the teacher enters the correct answer and calls up a display on a CRT mounted in a lecturn so he can easily read it. There will be a list of the student names, the answer they punched, and the aggregate number of right and wrong answers. These results are also recorded in the computer memory so that at the end of the class the teacher has a hard copy of all student responses and the correct answers printed out with summary statistics.

Comparing this function in the classroom and over two-way cable, it is evident that we lose the richness of discussion questions and student-teacher dialogue, but the immediate diagnostic capability over the cable is probably superior to that in the classroom. Not all students answer a verbal question in the classroom and there is no way to keep accurate records on performance. It is as though a formal written quiz were administered every day, and automatically graded. The teachers review the hard copy, enabling them to prepare for the next day's lesson. They can choose to repeat portions of the lesson, move on, or work intensively with a few students.

Informal Teacher Initiatives

The teacher also initiates many informal questions, many of them related to procedures and understanding of formal course content. The students will be asked to indicate whether they found an exercise to be too difficult, or whether they have completed an in-class problem that has been assigned. The distinguishing feature of these questions is that there are no right or wrong answers.

We also added to this area those interactions initiated by a teacher that involve a subgroup of students. Part of the class can be assigned to other tasks while the teacher works in depth with one or two who need special attention or are asking questions. Of course, if the teacher wishes to have diagnostics for a subgroup, he can use the Q mode.

As may be apparent, this "I" mode (as we call it) is entered by the teacher any time he wishes to ask questions and does not want recorded answers. The distinguishing feature in the software is that the teacher does not enter correct answers for the questions, and the answers are not compiled.

There is often some difference in the teacher's style between the two modes, caused in part by the need to enter correct answers in the Q mode and in part by the more casual purpose behind the I mode. From the perspective of the individual student, there is no difference in these two modes and he need not learn anything about the system. A question is asked, and the answer given.

<u>Student-Initiated Interaction</u>

The third mode is quite different because it seeks to provide the student with a way to initiate interaction. In the classroom, there are a rich array of both verbal and nonverbal cues and messages sent to the teacher. A bored student shifts in his chair; a frown signals confusion. A student may ask that the teacher repeat a point or he may ask a direct question about something that has been said. Again, one cannot begin to provide this complex capacity to interact with a data terminal, but we could at least give the students some opportunity along these lines.

In the current system, when the teacher is not asking questions, she puts the system into a third mode. Then when the student hits a button, his name and an alphanumeric message appear on the teacher's CRT instead of a number for a multiple-choice message. A great deal of thought went into determining the most common and most important messages these students would want to send. Since there were eight buttons and we had a single-stroke system, the student could send only eight messages. After some experimentation, we chose "I understand" (and the student is ready to move on), "I don't understand" (so please repeat and review), "slow down," "give an example," "ask a question" (so I can see if I understand), "visuals are unclear," and "technical problems." Each of these messages is printed on the student terminals by the appropriate button. Thus, when the student is asked a question, "3" indicates that the third alternative is the correct answer; however, when the student initiates the interaction "3" is a request for the teacher to slow down.

The flow of the three modes worked well. The teacher would put the system in Q mode and ask the students to punch in the answers to ten questions in quick succession as she enters and announces each correct answer in turn. Noting that three or four students consistently had the wrong answer for one type of question, the teacher would review the principle and then shift to the work mode and begin the day's lesson. Two students would send the signals that they don't understand what is being discussed, and the teacher--just as he would in the classroom--could choose to ignore the signal, or ask the class as a whole if they understand.

THE HUMAN QUALITY

The results of this effort have been encouraging. In the spring of 1976, the hardware was in place and courses began. Ten adult education students began a pilot class over the cable system in February in parallel with a conventional class at TEC. Final judgment about the educational efficacy of the approach must wait until the results are in on another series of cable classes held in the fall of 1976, but the signs are hopeful. Although we must emphasize the tentative nature of the results, the evidence suggests that the students who chose to take the high school equivalency course over the cable did as well as those who traveled to the classroom.

It is important to emphasize as well that the quality of the interaction that resulted from this design work has been very high. First, a cable teacher received a card from a student, on Valentine's Day thanking her for the personal attention she was giving that student.

A teacher's aide who operated a camera was mentioned during the course, and even though she was rarely seen, she got two get-well cards when she was hospitalized. These examples and other anecdotal evidence suggest strongly that the students felt the teachers cared about their progress in a personal and individual way, and we feel sure that that contributed to student patience with early technical difficulties and to student motivation to learn. All ten of the students stuck through to the end of the course--despite the fact that their basic tie to the teacher was a box with nine buttons.

Needless to say, the project has led us to a heavy emphasis on the importance of the man-machine interface. Even when the technology is well in hand, careful thought and design work must be put into choosing the way that people will be connected into a communications system.