Tutored Videotape Instruction: A New Use of Electronics Media in Education

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In the early 1970's, shortly after video broadcasting was proved to be technically feasible, Robert Frankel was said to have predicted that this new technology would someday have a dramatic impact on education. Subsequent events have shown that his assessment of the educational potential of video was probably correct, but, for a variety of reasons, the potential did not materialize. In the early 1970's, educational television was introduced with a similar fervor. However, with a few notable exceptions, its potential also failed to materialize. It seems that some recent technological advances such as compact audio-visual units and video-based educational delivery may come in a similar way. Why is it that these technological aids to education often seem to live up to their potential? There is, of course, a different set of reasons in each case, though inconsistent. In March 1977...
made. In this article we describe a new technique for using videotaped classroom discussions which we believe is more fun than the traditional methods used in most courses. The method makes use of an overhead projector and the technique has been used successfully in a number of courses at Stanford University.

In the past few years, the concept of the "video class" has been gaining popularity. A video class is a class where the students are seated in a classroom and the professor is in a remote location. The professor is able to see and hear the students and the students are able to see and hear the professor. The professor can also use the video class to give lectures, hold discussions, and conduct experiments.

In the video class, the professor is in a control room and the students are in a classroom. The professor can see and hear the students and the students can see and hear the professor. The professor can also use the video class to give lectures, hold discussions, and conduct experiments.

The video class is very popular among students and professors. The students are able to see and hear the professor and the professor is able to see and hear the students. The professor can also use the video class to give lectures, hold discussions, and conduct experiments.

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joined a close-up superior view over in-class instruction. From a combination of some of the most successful ventures in educational technology, such as Xerox Street, Chicago City TV College, the Open University in Britain, the Australian School of the Air, and the Bitumen TV Lecture, with some of the latest instructional aids, we attempted to ob-
sert a set of guidelines that would be able to define the conditions that were most like-
ely to ensure a successful application of technology in education. These guide-
lines, while they may need further refine-
ment and modification, do provide a use-
ful starting point for designing new pro-
gress. 

The guidelines are as follows: 

1) The educational program should be planned for a specific audience. 

2) Specific educational objectives that are relevant to the needs and interests of the audience should be clearly defined. 

3) Technologies should be chosen in terms of the topic to be presented. Fre-
quently, different technologies are used to present different parts of a course. The choice being determined from a consid-
eration of which technology is most effec-
tive for the material being transmitted. 

It is desirable (though also expensive) to use both knowledge and skills specifi-
cally to prepare and produce the pro-
gress. 

4) Educators who have an interest in learning and using the instructional characteristics of various media should be selected and trained. 

5) Clear and concise presentation should be aimed to avoid any confusions, espe-
cially among the students. 

6) Evaluation and feedback over a per-
iod of months or years should be used to monitor the educational effectiveness of the program, and the instructional mate-
rials and methods should be changed accordingly. 

7) On the standpoint of educational ef-
ficacy, the guideline is that perhaps most frequently overlooked is the one relating to personal interaction, espe-
cially where the use of instruction is con-
tinued. Televising including features that are videotaped for subsequent play-
back is most frequently used as a direct substitute for live lectures in large classes. The potential of making available to view features or programs as joint that are removed from the site of origin. 

These applications are developed pri-
marily to solve problems of cost and access. The assumption being made that courses delivered by television will be as effec-
tive as those delivered in the classroom. How-
ever, the experiences that led to this 

conclusion based only on the fact that in-class instruction lasted only a relatively brief period. Furthermore, they were not replicated. A more thorough study would have iden-
tified some characteristic weaknesses of television in an educational medium. In particular, as argued by Schlehan (1967), 
television does not stop to ask questions; it does not readily permit comprehensive 
discussion; it is an inefficient medium for conveying direct physical information; it is very well suited in individual differences; and it seems to encourage a passive form of learning. 

These are very serious weaknesses. They are not at a point degree by using radio talkback to check rapport with the television classroom, or by establishing a regular telephone con-
tact between students and faculty, as has been done by the Chicago TV College and others. However, these techniques for promoting student-faculty interaction are not easy to use or to evaluate. It is critically important for students to be able to speak to a person or a program when they have questions, and it is very desirable for the students to remain stopped long enough for the question to be clearly answered. It is also highly desirable that the answers to the most important questions be deve-
opmental in a program of educational values with.

A small group of students. Finally, it is important that questions and discussions be used to determine background defi-
ine for (individual) students, that to potential use must be taken. 

The major weaknesses of live televis-
ing include videotapes that are very 
imbly relatively but not necessarily com-
plete to the fact that it cannot provide the quality of personal interaction that are typically available in a good classroom. The TV Intelligent content, containing a small group of students, an on-site para-
professional tutor, and a course faculty member, who is present in an attempt to answer these deficiencies. What we seek to do is to provide small groups of students with the high-quality personal interaction that we need in order to learn effectively. What we have found is that TV can provide a means of achieving 

this goal. 

Experiment with TV 

We have carried out a number of ex-
periments to evaluate the educational ef-
ficacy of the TV format. All the ex-
periments to be discussed here have been 

concerned with the delivery of evidence-
ning and simulated sessions where the objec-
tives of the material is (relative

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...diagnose before they were moved to Stanford and had academic qualifications that were essentially identical to those of on-campus students, but students of Santa Rosa whose academic credentials were known to be inadequate for admission to the Stanford graduate school were also included.

2) In defining the educational objective, we knew that the students were entered in graduate training leading to a master's degree. A clearly important factor in their success was that their employers' shared this objective, in both its intellectual and academic aspects.

3) The technology used, half-hour color TV videotapes, was chosen to permit the clear reenactment of a given TV scene at the report sites. The videotapes were of two classes made by a trained student production staff so the scene was being conducted. The classroom decorations (but not necessary for this purpose) were described in Pottier and Groetz (5). Basically, the audio-classroom, are are arranged to interface as fully as possible with the teaching styles and preferences of the instructors.

The videotapes are mailed to Santa Rosa along with class notes, homework assignments, and other materials that are handed out to off-campus students. The tapes and homework are returned to Stanford approximately 1 week. When necessary, the TVI tutors telephone the off-campus faculty after the videotapes have been watched to discuss problems and obtain supplementary material.

4) The educational staff whose classes art not yet been reviewed are given a brief training session to acquaint them with the capabilities of the surveillance network and to offer suggestions concerning how these capabilities can be used effectively. how to organize blackboard space, use of a desk, and as an alternative to the blackboard, preparation of demonstration materials, and so on.

In addition, Stanford staff members who are responsible for the TVI program visit each site to discuss the videotapes among the company staff and to instill them in the use of the videotapes as an educational tool. An alternative to giving less experience in local educational institutions who have participated in the educational program. In most instances, the tutors are practicing engineers without prior experience in teaching. They are chosen primarily on the basis of two criteria: (i) their ability to present the material to students and of their ability to draw from their careful study of the two criteria, (ii) personal interest in reviewing the subject to be presented. Other criteria, such as their exposure to the course with evidence of high-quality performance, have been found to be less important.

The tutor's main functions are: to initiate and encourage stopping the videotape playback for the immediate rectification of problems; to answer if possible, questions that cannot be resolved by the class; and to show answers and supplementary material from the on-campus instructor if necessary. Tutors are also encouraged to visit the off-campus faculty once or twice a year to become familiar with the course syllabus and to discuss any existing problems that the students have.

The tutor is not responsible for grading the homework or assigning course grades.

5) Students and tutors are urged to stop the videotape whenever they find problems or questions or whenever some particular problem has been presented. Certain obvious cases are frequently used by the video in these discussions. For example, such a question as presented in the on-campus class, is often skipped and the TVI class attempts to generate an answer before the tape is wound.

In addition to extensive graphic interaction among the faculties, students are encouraged to discuss problems with each other and with the tutor outside the viewing period. Since the tutors and students are shown to each other through their common employment, there is ample opportunity for them to do so.

6) Critical records are maintained of TVI student performance on both homework assignments and examinations. Their performance is regularly compared with that of regular students in the campus classroom and local off-campus students receiving the same courses by way of IFPS.

The homework and test performance of the TVI students is analyzed by the Stanford TVI staff and the results are discussed with the tutors by telephone. Corrective measures are suggested when necessary. In addition, course evaluation questionnaires are given to the TVI students in order to gather their attitudes and reactions to the program.

Initial experimental results: After the first two quarters of operation, the TVI experimental program was evaluated by comparing the course performance of the TVI students to that of both the on-campus students and the IFPS students taking the courses via closed-circuit television.

One result of this evaluation is shown in Fig. 1, which is drawn from data obtained during the summer and winter quarters.
ter quarters of the TVI, a 3-hour school year. This figure shows the grade point average of the TVI students for all courses taken under the program. The students studied against their usual qualifications, the latter being a composite of prospective and graduating grade point averages (GPAs) and the qualifying component of the general record examination score. The correlation to the undergraduate GPA was based on a history of performance of students from the same schools during their graduate work at Stanford. Also shown in Fig. 6 is a similar data for on-campus graduate students taking the same courses as the TVI students. The regression plot shows the expected mean grade indicator to be the on-campus students' GPA, from which the average expected performance may be obtained for a student with given qualifications. It is apparent from Fig. 6 that as a group the TVI students underperformed their on-campus counterparts. That is, the average GPA of the TVI students (represented by the point labeled SR in Fig. 6) is higher than that of the on-campus students (labeled SU in Fig. 6); even though the average of the admission qualifications scores for the TVI students is substantially lower than that of the on-campus students. To make [the] more subtle observation, it is convenient to divide the TVI students into two groups: those with admission qualifications scores ≤ 0.2, who could have been admitted to the university as regular graduate students, and those with qualifications scores substantially < 0.2, who would not have been as such admitted. In terms of these subgroups, the data show that:

1. The subgroup that would have been granted admission did extremely well in their respective fields, and their performance was essentially independent of their admission qualifications scores.
2. The two students with the lowest qualifications scores did quite acceptable work (≥ 0.2); even the lowest GPA could not have been assigned to the Stanford Graduate School unless on their insistent demand. However, on the basis of their combined record of acceptable performance, it was suggested that they be admitted to the university as regular graduate students. A special program was developed for these students to prepare them for the general qualification examination.

In Fig. 7, the grades of the TVI students are compared with those of the on-campus students. The two groups received the same courses by TVI. The TVI on-campus students achieved a GPA of 3.58 out of a possible 4.00, which is typical of graduate electrical engineering graduates at the master's level. The students participating in the same course by TVI with both the back check capability of the classroom had a GPA of 3.9. The same conclusion was obtained when the on-campus students by an absent class of a grade point. This result is made more remarkable when we recall that several of the TVI students had attained academic qualifications that would have qualified them for the Stanford graduate program very quickly. It is also interesting to note that the performance of students at Stanford in the various courses without local tutors was obtained by only the best of the latter group, although the data in this case are very limited. The total number of course taken by students studying from videotapes with a tutor or student is somewhat smaller than that of on-campus students, although a similar result has been obtained recently at Stanford. In a much larger experiment, in particular he feels that both student satisfaction and course performance tend to decrease in the delivery method a change from on-campus televsion to live television presentation and videotape. It is sometimes argued that the industrial experience of the TVI students are far removed from the real world, but the TVI students were drawn from the same population as the students studying through TVI when they are well-prepared, so similar experiences might be anticipated for these students.

In other words, the students who have taken part in the TVI experiments are experimenters, whether full-time or part-time, and the results obtained in these experiments are of little interest. On the basis of these results it seems unreasonable to conclude that, for science and engineering courses, the TVI format is as good as the other methods of delivering television, because the method can be used successfully for other types of content. However, with the data we have today, it is difficult to support this hypothesis. We have, however, used the technique in two on-campus experiments to determine whether full-time graduate students could also benefit from TVI.

On-Campus TVI Experiments

The first of these experiments, which was performed over two successive quarters in a graduate electrical engineering course, was to develop a television course that was large enough that several TVI groups, varying in size and with different sessions and different students, were asked to take part in the experiments. The students were required to attend the lecture classes. The television was sent from the laboratory to the various locations and the students were given a set of notes and problems. The students who had performed equally well in the course during the previous year, but were not a part of the television group in the previous year, and were also interested in teaching in a regular classroom. Therefore, it was possible to compare the results with previous experiments to see if they were significantly different.

We have two groups of television students who have not attended the special classes. The first group is a group of 12 students, the second group is a group of 15 students. The first group was given a course and the second group was given a course. The results were very similar.
group, one with 2 members (identified as group 1) and one with 5 (group 2).

The separate TVI groups were too small for statistically significant differences to be manifested in their educational effectiveness. However, as illustrated by Fig. 3, the combined data show that the TVI method was at least as good as the control method. Furthermore, for students with lower admission qualifications, the TVI method at teaching appeared to be more effective than the regular class. In fact the regression lines for the TVI students (Fig. 3) suggest that the course performance is essentially independent of the student's admission qualifications. This finding agrees with the results given in Fig. 1 for the subgroup of TVI students whose admission qualification scores were sufficiently for them to be admitted to the university as regular graduate students.

Student opinions of the TVI format were also collected at the end of each quarter and showed a generally enthusiastic response to the method. Some characteristic features of their responses are shown in Table 1, with respect to (a) the effect of group size, a comparison of groups 1 and 2 (same topic) shows that the variable group was generally more enthusiastic about the TVI experience than the regular group. This trend general result has been repeated in our industrial TVI groups, and a comparison of all of our present data on group size leads us to the tentative conclusion that the method works best when the group size is between 3 and 10.

Table 1 also contains some specific information about the influence of learning styles on group size and group size. The studies indicated that the smaller the group size, the more likely that the students would engage more directly with the material, and that students who tended to answer questions directly (group 3) were less pleased than students in a group of equal size with a tutor who tended to draw them into the discussion when the topic was stopped.

The second set of experiments, performed during the winter quarter of 1976, were conducted with the second half of an introductory graduate engineering econometrics course in which the regular course professor was away from campus. In the absence of a suitable interim replacement, advantages of a shorter course from the previous year were shown to the regular class. A professed from the general student subject was reviewed thatTable 1. Student responses to selected video tape questionnaires: Percentage of students who answered "I found the tape helpful" were (a) 4.6 and 3.1 from 7th (strongly agree) to 0 (strongly disagree). Note that the high-tvability TVI group was on the average highly enthusiastic in all areas, though its course performance was considerably lower than that of the control group. Its low performance in the final test class. In fact, the high-tvability TVI group scored at or average of every 3-5 minutes.

Observations
The TVI technique was introduced in an effort to provide the benefits of both lecture and small group discussions to large group settings. Experience gained from 3 years of operation of the program suggests that the TVI technique is at least as effective as other classroom instruction for TV with some additional advantages, for both instructors and small group students. However, we can still do not yet possess the rigorous statistical test that can be made for the small group advantage. Nevertheless, we can see that the addition of video-tape lectures does offer the instructor an opportunity to preferential lecturing, and suggest, though we believe the general principles of the TVI format will

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The data indicate that the TVI method is at least as effective as other classroom instruction for TV with some additional advantages, for both instructors and small group students. However, we can see that the addition of video-tape lectures does offer the instructor an opportunity to preferential lecturing, and suggest, though we believe the general principles of the TVI format will
apply to a wide range of subjects and audiences.

To do so, consider the scope of the method. The method might be applied to situations either those described above for which we have formulated a fraction which we believe to be critical to the understandings or the TVF model.

1. The Attitude, Personality, and Instructional Style of the Teacher is very important. The teacher should be interested in the students and their audience. The teacher should be familiar with the students and their audience to ensure that the message is appropriate for the students.

2. Group size is also very important. Group size can affect the effectiveness of the method. The teacher should be aware of the group size and adjust the method to fit the group. Group size can affect the teacher's ability to individualize instruction.

3. Depending on the nature of the subject, the teacher may need to adjust the method to fit the group. For example, if the group is small, the teacher may need to adjust the method to fit the group size. Group size can affect the teacher's ability to individualize instruction.

4. Class size is also very important. The teacher should be aware of the size of the class and adjust the method to fit the class size.

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Impact of the Electronics Revolution on Industrial Process Control

Acceptance of advanced digital communication and control systems in the industrial plant will accelerate.

Lawrence B. Evans

The first computer control system went online in an industrial plant in 1936. Since then, there have been remarkable advances in our ability to acquire, process, and transmit information electronically. Developments in the technology of digital computer hardware, software, basic sensors, and all forms of communication offer the potential for industrial process control systems that are highly automated and provide improved operating performance.

The Role of Process Control in Industrial Plants

The focus in this article is on the "process industries" as opposed to the manufacturing industries. Products of the process industries include chemicals, petroleum products, metals, explosives, power, pulp and paper, food, cement, and textiles. These plants manipulate the composition of materials by chemical reactions, purification, and blending of components to convert raw materials and energy into more valuable products. A modern chemical plant is shown in Fig. 1. The earliest applications of computer control were in the process industries, where engineers were available to monitor the continuous flow of a product and to send the data to the computer, which could then direct changes in the process by adjusting valves and switches.

Automation in the manufacturing industries—automobiles, appliances, electronics—is beyond the scope of this article. Those industries manipulate the geometry of their raw materials so that discrete parts are assembled to form products. Computers are being used to control factories that run machine tools, track the contents of a warehouse, test products, and so forth, but the methods of measurement and control are basically different from those used in the process industries, and the problems of automation are greater (1).

Industrial processes are designed to operate in either a continuous or a batch mode. In the first, material flow continues through the plant from one processing unit to the next. At each stage, different operations are performed, such as heating, cooling, mixing, chemical reaction, distillation, drying, and precipitation. For trial operations, there are optimum conditions of temperature, pressure, and residence time at each stage. In the batch mode, the material being processed stays in one place (such as in a reaction vessel), and the process steps are carried out over time during the batch cycle. There is an optimum schedule of such factors in temperature and pressure. For large-scale production, engineers have traditionally tried to develop continuous processes, because they are easier to instrument and control, require less labor, and do not waste time in starting, cleaning, and refilling vessels between batch cycles (2).

Flow rates are in by far the most common variable manipulated, whether by adjusting a valve, turning a pump on or off, or by other means. The measured variables, in addition to flow rates, are usually temperature, pressure, chemical composition, and liquid level. A typical plant, such as one for manufacturing of ethylene or ammonia, will have several hundred control valves and more than a thousand measured variables. Changes are made in the operation of the process at a fixed time each hour or from a few seconds to a few hours.

The elements of a control system are shown in Fig. 2. The important functions are measurement, control, actuation, and communication. Measurement refers to the sensing of variables such as flow rate, temperature, pressure, level, and chemical composition, and the transmission of the measurement to the controller. Control is the decision-making operation; it compares the measured variable of the process with the desired condition and then decides how the variables should be manipulated. Actuation is the means by which the operating parameters are manipulated. Typical actuators are valves, motors, solenoids, and relays. Emerging technology of microprocessors and information to the plant operators as well as the transmission of important variables to the plant management.

The organization of a plant control system in a hierarchical structure is shown in Fig. 3. The lowest level is controlled by the control computer that regulates a single process unit to hold it to a desired operating condition and move the unit to a safe condition in emergencies. The next step is a computer responsible for coordinating several units for scheduling operations, and for estimating the plant's performance. At the top level is the corporate control computer.