DOCUMENT RESUME

ED 039 761 56 EM 008 097

AUTHOR	Podshadley, Dale W.
TITLE	Instructional Technology in Dentistry.
INSTITUTION	Academy for Educational Development, Inc., Washington, D.C.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Bureau of Research.
BUREAU NO	BR-8-0571
PUB DATE	[70]
NOTE	22p.; This is one of the support papers for "To Improve Learning; a Report to the President and the Congress of the United States by the Commission on Instructional Technology", ED 034 905
EDRS PRICE	EDRS Price MF-$0.25 HC-$1.20
DESCRIPTORS	*Dental Health, *Dentistry, *Instructional Technology

ABSTRACT

D. W. Podshadley discusses, in this paper, the roles in dental education of instructional technology, specifically single-concept films, simulation, dial-and-random-access systems, television, programed instruction and computers. He also discusses the continuing education of dentists, and looks at dental health in relation to the public. He summarizes that there is not enough dental health manpower to perform the important function of educating the public, and concludes that, if the job is to be done at all, it can only be with the assistance of available educational technology. (GO)

INSTRUCTIONAL TECHNOLOGY IN DENTISTRY

by Dale W. Podshadley*

Dental Education

The burgeoning population and ever-increasing individual demand for dental care has created a severe problem for dental education. In order to provide an adequate supply of dental manpower, new schools have been created and existing ones have expanded their enrollments. Between 1965 and 1975 the annual number of graduates will have increased 36 per cent, from 3,200 to 4,300.[1] Unfortunately, this dramatic and necessary increase in the student population has compounded an already critical problem -- the shortage of qualified teachers.

Adding to the problem of teacher shortage has been an expansion of the dental curriculum. As a result of social change and increased social awareness on the part of the profession, many new courses are being added from disciplines previously only remotely concerned with dental education. Psychology, sociology, anthropology, and political science are but a few of these new curricular elements. At the same time, the knowledge explosion has added immeasurably and will continue to add to the content of traditional courses.

It is obvious that, with an increasing student-teacher ratio and increasing subject matter content, constant effort must be directed at facilitating the effectiveness and efficiency of both teaching and learning in the dental school environment. It is essential that the use of modern instructional technology be increased and effective educational innovations be applied rapidly.

In recent years, there has been a great deal of interest in the teaching-learning process. This interest has served as a catalyst in the development of new

---

* Dale W. Podshadley is chief of the Professional Education Branch, Dental Health Center, Division of Dental Health, U. S. Public Health Service, San Francisco.

instructional strategies and instrumentation. These innovative developments attack a variety of deficiencies in the educational process. To alleviate the problem of personalizing and individualizing instruction, of combining the learning principles of immediate feedback, reinforcement, and active participation, programed instruction, and recently, computer-assisted instruction have shown great promise. For the problem of teacher shortage and that of reaching a large number of students at one time, educational television provided a partial solution. To solve the problem of providing information when the student wants it, dial- and random-access capabilities for both audio and visual materials have been developed. To enrich learning experiences by involving more than one sense mode, simulation techniques were introduced and newer media and devices have been developed - these include cartridge-loaded and single- and multiple-concept films and filmstrips, 35mm slides with their easy-loading projectors, overhead transparency series with overlays for step-by-step presentations, and various other multi-media kits designed to help the students acquire important skills and knowledge.

Dental education has kept up with this growing technology. There is hardly any dental school that is not equipped with a fair variety of audiovisual equipment, and most dental teachers use some type of audiovisual aid in their teaching. This, of course, is to be expected since dentistry is visually-oriented. Clinical procedures, chairside demonstrations, examples and illustrations of anatomical structures, simplification of complex processes and magnification of

minute objects lend themselves well to the use of audiovisual aids. There have been experimental and evaluative studies comparing the effectiveness of one medium with another or merely testing their feasibility, and in most of these studies, the results have indicated that audiovisual aids, when properly used, can make an invaluable contribution to learning. One such study was conducted at the University of Illinois College of Dentistry,[2] where the results of a study comparing the effectiveness of the lecture-demonstration with a synchronized tape-slide presentation in the teaching of dental technics showed the tape-slide group to be better performers. Another study, at Western Reserve University,[3] documented that dental students, when given the opportunity to pace themselves through the use of a manual and individual sets of colored slides, could save up to half the time traditionally provided for the learning of preclinical dentistry.

Even more important than research studies on the utilization of media is the preparation of the instructional materials themselves - the "software" in technological terminology. What is still needed, therefore, are more teaching materials, more efficient and organized ways of disseminating them, and a greater number of dental faculty trained to use them in an effective manner.

Single-Concept Films

Of the newer media, special mention should be made of the single-concept film. Dental education, with its emphasis on the teaching of specific procedural skills, has found this training aid to be of significant value. The simplicity of the projectors, the easy-to-load and protective cartridges, and the adequate

film capacity to handle all but the most complex of dental procedures, have added a dimension to dental education that previously was unattainable. For example, a recent study at the University of Iowa[4] investigated the feasibility of condensing a two-semester course in operative dentistry into three weeks of intensive study. This project made use of single- and multiple-concept films on the conceptual and procedural aspects of certain clinical skills. The results clearly showed that procedures in clinical dentistry can be taught effectively in a shortened period of time. The films have since been placed in convenient locations for individual use by students for the recall of a particular procedure immediately prior to providing the service to a clinical patient.

Simulation

Dental educators have always been faced with the problem of providing adequate clinical experiences for future dentists. Although opportunities are provided for the students to experience a variety of situations during their clinical years, it is virtually impossible to expose them to many situations which they will ultimately encounter in their professional practice. It is true that there is no substitute for first-hand learning experiences, but since some problems do not occur at scheduled and at specified hours, the next best way to enrich the students' educational experience is to simulate life-like situations that are likely to occur in the dental office.

Simulation as a teaching method provides a unique learning experience whereby a situation may be repeated as often as desired, thus giving the student

practice in discriminating cues that identify a particular problem. Since a group of students or a whole class can experience the same situation through simulation, a common frame of reference is established. In this way, the group can discuss a particular problem more realistically and evaluate the results more effectively. Many problems in dentistry, particularly those related to determining a diagnosis and a plan for treatment, are amenable to simulation.

In dental education, however, the potential of simulation as a teaching approach is just beginning to be realized. At the University of Oregon,[5] a series of filmed emergency episodes have been prepared that are of considerable value in teaching dental students to cope with emergency problems which may be encountered in private practice. This basic technique is also being used at the University of Alabama,[6] where community experiences are "acted out" on videotape to prepare students for their roles in society as community leaders in matters pertaining to oral health. And at the University of Michigan,[7] a series of short films designed for in-service teacher education is being developed. These films will simulate the most common teaching problems which occur in the laboratory or clinic and will illustrate good and poor solutions to these problems.

Even more realistic than filmed or videotaped versions of actual situations are life-like, life-sized manikins, such as the computer-controlled SIM ONE, developed by the University of Southern California School of Medicine to improve the training of anesthesiologists.[8] It is planned that a similar manikin for the training of dental and dental auxiliary students will be developed by the

Education Research Branch of the Division of Dental Health. This computerized head and neck manikin will simulate a variety of human characteristics and responses. For example, thermistors placed in pulp chambers will respond to excessive heat causing a pain response, salivation and circulation of blood will be provided, appropriate responses to correct and incorrect local anesthetic procedures will be included, and the maxillary and mandibular arches and contiguous tissues will be removable so that a variety of clinical problems can be presented to the student. Ideally, this manikin would simulate nearly every human response conceivable in dental practice, e.g., an allergic response to an anesthetic or a coronary occlusion.

Dial- and Random-Access Systems

A great deal of progress has been made in the area of information storage and retrieval during the past few years. With the tremendous amount of printed materials published and the rate at which new materials are being developed, the need to store and disseminate them effectively is of paramount importance. The availability of the microfiche provides a solution to the storage problem; the dissemination of materials, however, is still far from satisfactory.

This need has resulted in the development of the dial-access system. With this new technology, it is now possible for a learner to have immediate access to any prerecorded material he needs--audio and/or video--from any place and at any time by simply dialing a number or pushing a button. Even more promising than the dial system, where only one student at a time can be connected to the

beginning of the program source, is the potential random-access retrieval system, where anyone who dials in to a program of his choice can be connected instantly to the start of the program.

Dial-access is already a reality in a number of schools throughout the country, but to date, the dental field has made only a modest beginning in the area of learning through prerecorded instruction. A significant amount of planning to introduce this system has been done by Loma Linda University School of Dentistry, but the system is not yet operational.

The concept of the retrieval system, especially if it is random-access and under computer control, has tremendous implications in the field of dental education. The immediate access to a library of prerecorded instructional materials when the learner needs them would provide the flexibility and individualized learning that is required if dental students are to progress in accordance with their individual capabilities. This element is of prime importance in the learning of psychomotor skills, where individuals differ widely in their conceptual and digital abilities. No longer will the student be forced into lock-step learning; no longer will he be held back or pushed ahead of his capabilities by other students in the class; no longer will he depend on the teacher or on the traditional library to dispense the information he needs at the moment. Since this dispensing of information can be done electronically, there will be more dialogue and communication between teacher and learner, and more time can be devoted to individual learning problems.

Television

An instrument that is capable of transmitting oral and visual information of any size to any group simultaneously is bound to have important implications for teaching and learning. For this reason, television has an important role to play in dental education. The capabilities of image magnification and image storage on videotape are particularly valuable.

Television was first used in dental education in the early 1950's at the University of Detroit School of Dentistry. Since then, a number of dental schools have made use of this medium of instruction. At the University of Texas, one of the pioneer dental schools to use television, basic science and clinical courses, as well as examinations, are televised into small laboratories and private operating rooms. Response mechanisms are provided to each student so that questions can be asked during the televised lectures and demonstrations. At the University of Kentucky, televised lessons are not only scheduled as part of a course, but they frequently are also immediately available for viewing by students who may have missed the lesson or who may feel the need for a review. The value of television in dental education has been documented by the University of Pennsylvania, as well as other schools of dentistry.[7]

At present, almost all the dental schools in the country have television installations or have access to television facilities. Research in television technology, however, continues. An example may be seen in the University of Texas Dental Branch where 3-D television to show perspective and dimension has been

developed.[10] Another innovation is a prototype optical scanner for the inspection and display of intra-oral anatomy with remote television viewing, planned for development by the Forsyth Dental Center in Boston.

Unfortunately, one capability of television which would have immediate impact on the problem of the shortage of teachers is not yet being used to any appreciable extent in dental education. This capability is the sharing of great teachers through the use of videotape. The cause of this situation, however, is not entirely attributable to the lack of action on the part of dental educators; rather, a bigger reason probably is the lack of compatibility within the television systems.

With the continuing upsurge in technological innovations, however, it is conceivable that in the not too distant future, all classrooms and laboratories in each dental school in the United States will be equipped with television monitors linked to a computer, making it possible for a student to tune in a program or a course of his choice anywhere and at any time.

Programed Instruction

Programed instruction appeared on the educational scene only a few years ago, but it has already gained rapid acceptance in business, industry, and the military. This is so because training objectives in these fields are easily defined and the development of training programs are not bogged down by policy decisions. The acceptance of programed instruction in educational institutions, however, has been relatively slow, and dental education has been no exception.

Perhaps the biggest single factor influencing the applicability of programed instruction to dental education is the lack of agreement from one institution to the next regarding what is taught in a particular course. In other words, controversy over the subject matter itself over what ought to be covered or what should be emphasized blocks the widespread acceptance of material programed by a single teacher or a group of teachers in one school. Individual teachers, therefore, are left with the task of preparing their own materials, or at least modifying what others have prepared to meet their particular needs. Unfortunately, because of the teacher shortage, few dental faculty members can afford the time and effort required to prepare their own materials or to modify those of others.

The use of programed instruction in dentistry is still on a small and on an experimental scale. Programs developed to date are on dental materials, dental anatomy, gingivectomy, dental public health, operative dentistry, four-handed dentistry, oral cytology, oral pathology, endodontics, and a few others. However, the research that has been conducted regarding its feasibility and effectiveness has demonstrated the potential of this new approach to dental teaching.[11,12] This comes as no surprise since programed instruction is an organized and systematic approach to teaching in the sense that it presents the information to be learned in small steps, requires active participation by the student, and provides immediate feedback and reinforcement. Here again, because it is a self-instructional method, its use would result in better utilization of students' time and would relieve the instructor of many routine classroom activities, thereby

giving the teacher more time to devote to individual discussions with his students. From all indications, programed instruction has a definite place in the field of dentistry. It is doubtful, however, that it will achieve this place until an easy way is found to introduce the teachers' objectives and knowledge into an automated system.

Use of Computers in Education

The latest technology that has appeared on the educational scene and the logical extension of simple programed instruction is computer-assisted instruction (CAI). It incorporates many of the learning principles characteristic of programed instruction but on a more sophisticated level. This system provides even more individualized instruction in the sense that course modification and revision can be made continuously by the author through the computer, in accordance with the student's individual responses. With CAI, therefore, there is an even closer interaction between author and student than in programed instruction. Thus, while the hardware is an important part of the CAI system, it is still only a tool; what actually teaches is the computer program itself. Credit must be given to the author whose knowledge and application of important teaching-learning techniques are still prime requisites.

A few CAI programs in dental education are in the process of being developed. The Harvard Computing Center is planning to investigate the feasibility of CAI in the teaching of gross anatomy related to the oral cavity. This study will be concerned with improving the retention of anatomical information through

the programed display of perceptual aids to verbal learning through a CAI system.[13] In dental education itself, the Universities of Michigan and Iowa Schools of Dentistry probably have been the most active in planning for the future of CAI. Michigan has designed its new school with CAI in mind while Iowa recently developed a short course in a clinical subject for CAI.

Although CAI is a fairly new concept in education and therefore is still largely experimental, the computer itself is no longer a novelty. In business and industry, the use of computers in doing routine accounting procedures such as billing, filing, and payroll is commonplace. This usage of computer-based systems has now expanced into operations research, systems engineering, simulation models, and human factors analysis. Computer applications in educational institutions, although considerably slower than in business and industry, are gaining widespread attention and recognition. Most large universities and libraries in the country today are now relying on computers to do the usual administrative tasks of data acquisition and data processing.

Effective and efficient use of computers in an educational environment can be seen in simulating learning environments, automating and retrieving information, controlling variables for the study of learner-instructor interactions, integrating instructional media into the curriculum, and in decentralizing the educational system by bringing remote educational resources into the classroom, study carrel, library, and even into the home.[14]

The implications of computers in dental education and research are indeed far-reaching. The routine procedures of scheduling clinic time and chairs, determining patient load, keeping periodic records of individual progress, scoring and analyzing students' examinations, and a host of routine functions that will greatly increase the efficient use of time and facilities for the faculty and students are particularly amenable to computer applications. These functions, although only indirectly related to instructional technology, have a direct relationship to educational economy.

At the University of North Carolina, a computer project is now underway to test the feasibility of patient scheduling in accordance with the total patient care concept. In this project, the treatment needs of the patient are being matched with the level of ability of the student. Simultaneously, faculty-student ratios are being determined for specific clinics depending on anticipated problems.[15] Computers are being used by a number of schools, including the University of Maryland and the University of Southern California, to analyze quantitative and qualitative performance data on dental students. The University of Missouri at Kansas City has designed a dental examination and treatment chart to be used in conjunction with an IBM computer. New York University is presently investigating the use of various data processing methods for the collection and evaluation of students' work accomplishment and grades in the clinical departments.[16]

The real contribution of computers to education, however, probably will come about in the instructional process itself; it is not unreasonable to hope that

in the near future, a few high-speed computers will be strategically located in various parts of the nation to serve all the dental schools as instructional centers. From these centers, programs written by subject matter authorities will radiate to the various dental schools where students can learn at their own convenience. And if the trend holds true for education as it has for business and industry, exciting possibilities are likely for systems analysis and computer simulation in the complex processes involved in and related to dental education and research.

Continuing Education of Dentists

There are about 100,000 practicing dentists in this nation today. The task of keeping them refreshed in the old and abreast of new developments in dentistry is formidable, since the "information explosion" in the dental field has increased geometrically in recent years. New skills, technics and procedures, new drugs, materials and treatments, and new applications of old procedures have all appeared, but they are of little value to the health of the nation until they are understood and fully utilized by the individual practicing dentist. Improved instructional technology is of immediate relevance.

The problems facing continuing dental education are both similar and different from those in undergraduate education. Much of the knowledge and many of the skills to be taught are alike; the problems of communication, particularly in relation to the level of the learner, are considerably different. Fundamentally, the difficulties center around the diversified needs of individual dentists, the geographic dispersion of dentists, limited teaching manpower, the

lack of a broad curriculum in continuing education, and the lack of a coordinated system at local, state or national levels to plan, develop, implement and evaluate continuing education programs to reach the nation's dentists throughout their lifetime of practice.

Unlike the requirements for undergraduate education, the educational needs of the practicing dentist are highly personal and reflect his own characteristics and those of his practice. A determination of specific educational needs represents the base from which sound guidelines are drawn for administering programs, defining educational objectives and selecting topics, instructional materials, methods, and media. The best in instructional technology is of no value if it provides what the dentist neither wants nor needs. To solve this problem, during 1967-68, surveys have been conducted throughout six New England states, the South, Midwest and Western states in an effort to identify the dentists' needs and preferences in continuing education. In 1969, the Continuing Education Branch of the Division of Dental Health will publish these findings as a series of Profiles of Continuing Education.

Complicating the previous problem is the fact that nearly half of the nation's dentists are not located within reasonable distance of a dental school, the traditional setting for educating the dentist, primarily through providing short courses and post-graduate training in various topics. Even for those dentists who are able to avail themselves of these courses, several drawbacks are apparent. First, the dentist loses economically through the requirement to close his office

during the period of training. Second, the public loses his services as a practicing dentist for the same period, a problem when a severe manpower shortage exists. It is obvious that both mass and individual methods must be found to bring continuing education to the dentists and still preserve high-quality instruction.

One answer to the geographic problem is a greater use of off-campus community settings for continuing education. There is ample opportunity in the community environment to present various courses, workshops, seminars and clinics in a highly personalized way. Subjects that do not demand intensive clinical instruction are especially suited to the community setting and a major portion of subject matter falls into this category. Even when material is presented which requires clinical application, the practitioner's office, the local hospital or the community clinic can serve as a substitute for the clinic facilities of the dental school. Mobile satellite centers also could bring continuing educational opportunities to the dentist in his own community.

Unfortunately, as has been mentioned previously, there is a critical shortage of teachers. The traditional role of the teacher, developing courses and presenting them to the students in a face-to-face relationship, is not possible. Fortunately, the use of live television, videotape, films, two-way radio, teaching machines, and other media has extended the teacher's time and talents. More effort must be devoted to course development, however, when a live teacher will not be available for the presentation. Clarity and the sequential

organization of the teaching materials assume new importance when no one is present to answer the learners' questions.

The development of effective and efficient courses that can be considered self-contained almost always requires the use of a "team" approach. This team might consist of a dental specialist, an educator, an audio-visual specialist, a graphic artist, and a writer, each of whom assumes responsibility for certain elements in course development.

This team approach currently is being used by five dental schools, with the support of grant funds, in the development of course materials for off-campus presentation. The University of California, San Francisco, and Temple University are preparing self-instructional programs; Tufts University is presenting dental reports via open-circuit television and is activating mobile satellite teaching teams for demonstrations; the University of Iowa is preparing materials for evaluating teaching machines as well as developing "field" faculty among private practitioners; and the University of Pittsburgh is expanding existing regional centers for continuing dental education and establishing new centers, utilizing a wide variety of educational methods and media.

Although the methodology for course development in continuing education may be well-established, a major void still exists in that a curriculum has never been defined. Hopefully, this problem will be resolved soon. Under development are teachers' guides in the major areas of dentistry. These documents will define the "ideal" performance required by the student (as seen by dental

educators) and will serve as a guide for teachers to develop appropriate course content and instructional methods and media. The guides also will have the potential of serving as self-evaluation tests which practitioners may use to determine their own continuing education needs. Eventually, this self-diagnosis of needs should be accomplished quickly and easily via computer.

At the present time, probably the biggest shortcoming in the continuing education of dentists is the lack of a coordinated system at the local, state, or national levels to plan, develop, implement and evaluate continuing education programs. The requirements of such a system are not simple. To provide educationally sound courses which are readily accessible and financially feasible, and which will meet individual and group needs without the physical presence of a teacher is a difficult but not hopeless task. The answer undoubtedly lies in improved instructional technology which emphasizes the systems approach. The eventual use of vast information storage and retrieval sources, computer control, and satellites for transmission may be the answer.

— Dental Health Education of the Public

Dental disease has not received the attention from the public that it deserves. This is probably because of its universality and its non-threatening nature as a critical health problem. A wide discrepancy exists between the American public's knowledge about oral health and what it practices in meeting oral health needs. This situation is untenable since the individual can and must assume considerable responsibility if the oral tissues are to be maintained in a healthful condition.

To date, little has been done on a systematic basis to motivate the public to acquire good oral health practices. Although the professional associations and many commercial groups have prepared and distributed a broad array of informative pamphlets and audiovisual aids, few research studies have been conducted to evaluate the effectiveness of these materials in producing attitudinal and behavioral change. It is likely that dentifrice advertising has contributed more to the public awareness of the importance of dental health than any other medium.

Probably the most effective tool for motivation has been the patient education provided in the individual dental office. In the past, this function has been carried out largely by the dentist who, unfortunately, has not always had the training necessary to provide sound educational experiences for the patient. More recently, the role of patient education has been assumed to a large degree by the hygienist or assistant. Today, these efforts can be supplemented with a variety of educational materials, particularly programs on record-filmstrip devices. These devices and a variety of "canned" programs for individual use can contribute considerably through providing sound educational messages without a proportionate loss in productive dental manpower.

One of the most fundamental places for providing dental health education has been largely ignored. This place is the public school system. Whatever the reason, the lack of trained personnel, the lack of good teaching materials, or the lack of curricular time, little has been done to promote dental health in the

schools on other than a sporadic and frequently unorganized basis. The public school system is also the place to begin educating socially disadvantaged children as to the importance of seeking dental treatment. Even when the economic blocks are removed, the socially disadvantaged are not prone to seek dental treatment; their values and life outlook militate against it.*

Perhaps one solution to this dilemma is through the use of educational television. With good sequential programing, many students could be reached throughout the primary and secondary years with proved motivational instruction. Audiovisual materials can be prepared which will produce fundamental changes in values among specific groups. This same approach might also be used to provide good dental health education to the public at large.

To summarize, there is not enough dental health manpower to perform the important function of educating the public. If the job is to be done at all, it can only be with the assistance of available educational technology.

---

* A recent publication by the U.S. Department of Health, Education, and Welfare has this to say: "The diffuse fatalistic feeling of powerlessness which informs so strongly the relationships of the poor to the rest of society is embodied most pathetically in resignation to illness. . . For example, one finds very often the idea that total loss of teeth is ultimately inevitable. . . It is fairly common to learn that a person has had some or all of his teeth removed in preference to paying for their restoration to working condition."[17]

REFERENCES

1. Hillenbrand, H. The scope and urgency of the dental manpower problem. J. Am. Coll. Dent., 35:113-122, 1968.

2. Barber, T. Synchronized tape and slides as a method of teaching dental technics. J. Dent. Educ., 28:43-53, March, 1964.

3. Vanek, H. G., Chen, M. K., and Podshadley, D. W. Evaluation of a self-instructional method used in preclinical operative dentistry. J. Dent. Educ., 31:34-43, March, 1967.

4. Darby, D. W., Chen, M. K., and Podshadley, D. W. Experimental study of an intensive course in operative dentistry. J. Dent. Educ., 29:419-425, Dec., 1965.

5. Jarabak, J. P. Teaching dental emergencies through simulation techniques. Paper presented at the annual meeting, American Educational Research Assn., Chicago, Feb., 1966.

6. Ramirez, A., Miller, S. L., and Pelton, W. J. Use of simulated experiences in teaching community dentistry. J. Dent. Educ., 31:521-7, Dec., 1967.

7. Hansen, R. G. Personal communication. Oct., 1968.

8. Abrahamson, S. A computer-based patient simulator for anesthesiologists. Univ. of So. Calif. School of Medicine, Los Angeles, July, 1967.

9. Romano, M. Use of television in dentistry. J. Dent. Educ., 28:432-93, Dec., 1964.

10. Morrison, W. E. 3-D in medical-dental teaching. Paper presented at the DAVI annual meeting, NEA, Houston, March, 1968.

11. Podshadley, D. W. Programed instruction: highlights of its use in teaching public health. Am. J. Pub. Health, 55:887-91, June, 1965.

12. Podshadley, D. W., et al. Learner attitudes as a variable in the use of programed material. Paper accepted for publication in J. Dent. Educ., 1968.

13. Stolurow, L. M. Personal communication. April, 1968.

14. Bushnell, D. D. New applications of computer technology for the improvement of instruction and learning. In The Computer in American Education - Issues and Applications, Stanford School of Education Conference, Nov., 1965, 174-96.

15. Crandell, C. E. The feasibility and merit of introducing the total patient care concept into the dental clinics through the use of linear programming techniques. Paper presented at the annual meeting of the International Assoc. for Dental Research, San Francisco, March, 1968.

16. American Association of Dental Schools. Report of research projects in dental education, 1965-66. Chicago, April, 1966.

17. Low-income life styles. U. S. DHEW, Welfare Administration Publication No. 14, Washington, D. C., 1966, VIII + 86 p., p. 59-60.