The Development of VITAL: A Microcomputer-Based Videotex Teaching and Learning System for Education

George A. B. Moore

Abstract: Recently, considerable interest was aroused about the potential of Videotex for educational purposes. In Canada this was Telidon which in 1983 was upgraded to the NAPLPS standard. This study explored the use of Telidon for instructional purposes. Limitations in existing Telidon system software for instruction and the high costs of the conventional Telidon approach led the project team to develop and test a micro-computer based course authoring and presentation system called VITAL.

Findings from the study with eight instructors revealed a high degree of student acceptance for the colour graphic materials, especially in visual science disciplines. It was also found that time required to produce instructional materials, while considerable, is substantially less than that reported in the general literature.

Using Computers and Telidon in Higher Education

While computers have been used in university education for the past 2-1/2 decades (Alpert & Bitzer, 1970), high costs, lack of experience, unfamiliarity and a high.degree of social inertia have resulted in a relatively slow adoption outside a few selected disciplines (Digital, 1985). This has changed in the past 5 or so years and today the elusive potential of computing is coming closer to our grasp. As powerful and appealing as are the new developments in low cost computing, the essential factors in good educational applications are not the machines themselves but the instructional purposes to which they are placed. The most critical areas for attention are the development of instructional design capabilities among instructors and some attention to the context in which the instructor is engaged with this newer medium.

The emergence of the lower cost personal computer and the growing availability of good quality software packages for word processing, spreadsheet analysis and file management have opened up the use of the microcomputer as a valuable tool for both faculty and

George A. B. Moore is Associate Professor and Director of Rural Extension Studies at the University of Guelph. His teaching and research interests include communication technologies and diffusion of innovation and its educational impact. The work reported in this paper was jointly funded as a staff development project of the University of Guelph and Tayson Information Technology, Inc. as an outgrowth of the Federal Department of Communication MSP Project. Informart, Winnipeg, also provided valuable assistance through its Grassroots system. Individuals who contributed in the development of the project included: Dr. T. J. Gillespie, Dr. T. F. Herrmann, Dr. A. L. A. Middleton, Dr. D. K. McIntosh, Dr. G. D. Partlow, E. M. Black, T. J. Bruce, K. R. Pituley, L. G. Richards, P. A. Richardson and W. G. Taylor.

students. This use, however, is distinct from the use of the computer in instruction (Pylyshyn, 1984).

During the early 1980s considerable interest was aroused in Canada about the potential of Telidon for educational purposes. TVOntario embarked on a Telidon field trial, the University of Victoria pioneered an Apple II based Telidon page creation system, the University of Waterloo developed a CPM based storage and delivery system, Athabasca University developed database software for Telidon to operate on Unix host computers, and the Ontario Educational Micro computer specifications, which led to the ICON, required such machines be capable of handling Telidon code.

In the initial stage of Telidon the system consisted usually of a reasonably sized mini computer as a host for the database, a special purpose hardware decoder terminal and telecommunications between the two. More recent developments have reduced the size and cost of systems using Telidon code which in 1983 was replaced by an expanded standard, the North American Presentation Level Protocol Syntax (NAPLPS). One of these systems is a development at the University of Guelph called VITAL (Videotex Integrated Teaching and Learning). A more significant development is the migration of Telidon/NAPLPS from single purpose hardware to microcomputers through the use of software decoders.

While NAPLPS has replaced Telidon as the North American standard for this unique form of colour graphic and textual display, both belong to a generic family identified here as Videotex.

A Pilot Study in Using Computer-Based Videotex Instructional Materials

In 1982 the University of Guelph received an equipment award of $76,000, on a matching funds basis, from the Industrial Investment Stimulation Program (IISP) of the Canadian Department of Communication for the study of Telidon applications. This award specified three areas of study and application: an agricultural information service, an on-campus electronic information service for staff and students and the use of Telidon in teaching (Moore, 1985a).

The first area of study, agricultural information, was undertaken in 1983 as a joint venture with Infomart, the owners and operators of the Grassroots service for farmers based in Winnipeg, Manitoba. This service began in April, 1981, and at the time of the Guelph study was limited geographically to the western Prairie provinces. In April, 1983, it began operating in Ontario through the University of Guelph's trial and in July, 1984, the service expanded into the eastern USA as Grassroots America.

The joint project gave the University immediate access to the considerable computing resources and to the expertise of the Infomart staff which were in place to support several commercially operating Telidon services. It was possible for the University's instructional applications project to be mounted *piggy-back* on the agricultural service. The computer equipment available comprised a VAX750 and a VAX780 with Infomart Telidon System Software located in Winnipeg. These computers and software carried the database and provided the system's traffic control.

A dedicated dataroute line was purchased between Guelph and Winnipeg and equipped with a 16 channel concentrator. Two of these channels were used by the University's page creation staff to upload material into the database, 4 were used for the instructional project and 10 for the agricultural service.

University owned equipment included two Norpak EPS microcomputer systems for creating the Telidon pages and 50 user terminals of which 6 were allocated to the pilot study and connected to Winnipeg via the University's computer network and the dedicated dataroute. In operation, a student using the system was connected to the Winnipeg database as if it were an on-campus facility.

By the summer of 1983 computer applications to instruction were limited to several simulations running on the mainframe and two VAX dedicated to courses in computer science. No generally accessible instructional computing facility was available to members of the University community. The microcomputer pools and networks in the Colleges of Physical Sciences and Agriculture were in the first stages of planning but were not operational. Thus, in August, 1983, a pilot project was undertaken to enable four professors to test the available Telidon/NAPLPS facility for instruction.

The initial instructional materials created for the pilot study comprised interactive testing modules for courses in Extension Education, Neuroanatomy, Ornithology, Psychology and Zoology. These courses were selected because of their high visual content and the fact that high quality, low-cost colour graphics are one of the principal characteristics which differentiate Telidon/NAPLPS from other computer systems.

A three-step process was used to create the instructional materials. First, the instructors participating in the project selected segments of the course for treatment in consultation with an instructional designer. The material was then arranged into "frames" on paper as it would be viewed by students. Second, a staff graphic designer coded this information into Telidon/NAPLPS "pages" using the Norpak Telidon frame creation equipment. This step required frequent consultation with the instructor to ensure the accuracy of the final Telidon/NAPLPS "page." Step three required the programming of the "pages" to achieve the instructional intent.

Telidon databases at the time were basically tree-structured with users working through the material from a series of progressively specific menus. This was deemed too restrictive for interactive instructional uses and special purpose action task sub-routines were created by Infomart to handle this requirement.

Two instructional approaches were used in the pilot study. The first was to complement courses with a need for frequent student testing and feedback. The courses here were in extension education, neuroanatomy, ornithology and psychology. A second application was undertaken in Introductory Zoology where 600 students made heavy demands on the instructor to "see again" after class his colorful overhead transparency illustrations. In this case the materials for the course, Animal Kingdom, were prepared as a reference database accessible in the library. Figures 1 and 2 (See next page) show examples of the materials prepared for courses.

In all cases the use of the Telidon/NAPLPS system represented an adaptation to an existing instructional approach. This resulted in a very fast turn-around of approximately 4 weeks from the initial decision to use the system until the course materials were available to students.

The Role of the Instructors and the Pilot Study

A key consideration in any innovation is the willingness and readiness of participants. In this project this included both the faculty and their students. Rogers (1983) lists five key factors in the adoption of innovations in a social system. These are perceived relative advantage, compatibility with existing practices, complexity of the innovation, trialability or the extent to which the innovation can be explored without making a major initial commitment to adopt, and observability or the degree to which the innovation can be seen by others.

While the pilot study was undertaken to assess the feasibility of Telidon/NAPLPS as an instructional medium, several of the participating instructors viewed it as an innovation in their teaching. The motives and reasons for taking part in pilot projects are tied more closely to one's primary responsibilities and concerns than they are to the researchers' need

FIGURE 1.
Frame from Reference Material in Zoology.

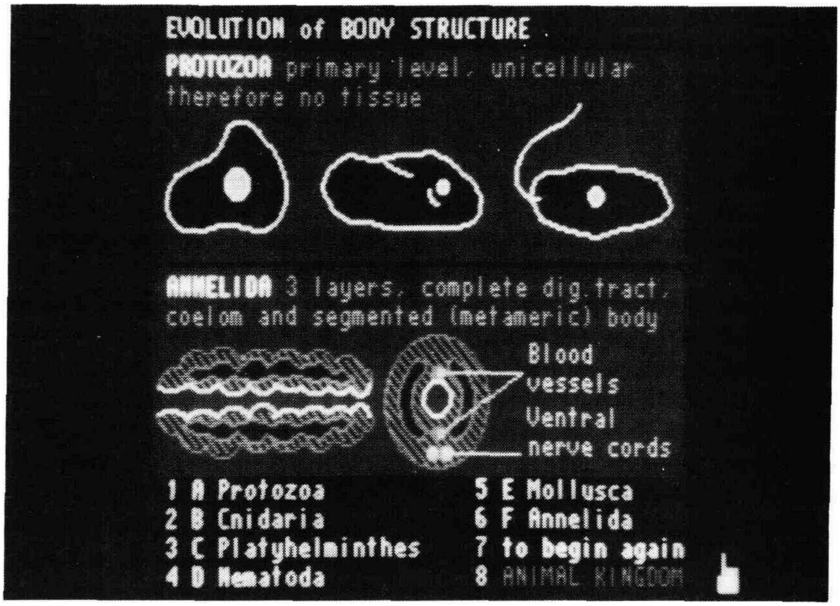


FIGURE 2.
Frame from a Test Package in Ornithology.

to know. Thus it was found in this project that serious attention had to be given to the participating instructor's needs as distinct from those of the investigators.

In keeping with Rogers' principles an attempt was made in the Guelph Study to select courses with instructors who had perceived instructional needs which might be served by the project, and those whose existing instructional organization was compatible to and could accommodate this computerized application without major reorganization. Three of the courses were using a Personalized System of Instruction (PSI) or Keller Plan type instructional format so the Telidon/NAPLPS materials were adapted to provide student testing and feedback. The other courses used the system to present biological graphics and schemata. In keeping with Rogers' principle of trialability, only portions of these courses were treated in the pilot study.

One of the four instructors involved in the pilot study had previous experience with using the computer for instructional purposes, while for the other three this was a novel undertaking in which the complexity of the procedures was an important consideration. This was handled by using staff in the Telidon page creation centre to work with the faculty members in designing, producing and programming the materials. The role of the instructor was as content authority in determining the material to be presented to achieve the instructional intent and to monitor the work of the design staff to ensure resulting computer material conformed to the objectives.

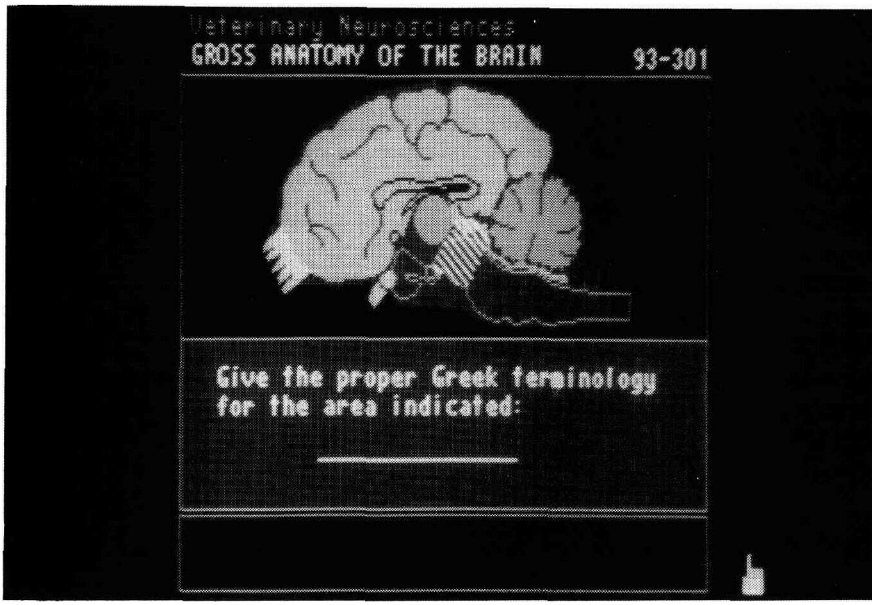
Information and demonstration sessions for other instructors were held at various points in the project where the pilot participants described their experience and demonstrated their material. Materials were developed for four more instructors as a direct outcome of reports from the pilot project.

FIGURES.
Frame from Course in Geology Showing Student Workstation.

Student reaction was measured by surveys taken in the Winter and Fall semesters of 1984. They reported the system as easy to use, the colour graphics of value and expressed an interest in continuing its use (Moore, 1985a). The opportunity for self-pacing, immediate feedback, individual and group study, the quality and variety of questions, the stimulation of recall and the emphasis on student learning were listed by the students as advantages of this approach

Leppmann and Herrmann (1982) have been using the Keller Plan (PSI) as both a

FIGURE 4.
Frame from Course in Neuroanatomy.



means of teaching introductory psychology and as a field for research. They have found that students perform consistently one letter grade higher on common departmental examinations than students in lecture/discussion sections. However, students also report a much higher workload in a PSI type course (Hermann, 1984). In their existing PSI applications Leppmann and Herrmann had used trained student facilitators to conduct the quiz sessions and provide for feedback. The number of quiz sessions began to present budgetary difficulties which in turn led to a search for computer-based alternatives. In a separate trial project, Herrmann began the development of a computer testing system GATES (Guelph Automated Testing and Educational System) operating on the Department of Computing and Information Science's VAX. This was made available on a concessionary basis for the research but was normally restricted to Computer Science courses and unavailable to other teachers.

In a comparative study between Telidon/NAPLPS and ASCII displays for instructional material, Herrmann (1984) found a strong preference for the Telidon/NAPLPS type of graphic display. This study involved students in a third year psychology course and compared student perception of workload with achievement on final examinations in each of three instructional modes. A control group received instruction in the traditional lecture/discussion format. The two treatment groups received instruction in the PSI format with the mastery quizzes and associated feedback provided by computer-based delivery. Treatment Group I received test items presented by standard ASCII monochrome display. Treatment Group II received the same items formatted and displayed using Telidon/NAPLPS. In both treatment groups the test items were text without visual illustration, however, the Telidon/NAPLPS materials were constructed to take advantage of graphic design characteristics of layout, colour, text size and spacing inherent in Telidon/NAPLPS. Apart from these graphic design aspects of the display, the content of the test items for Treatment Groups I and II was identical.

In the control group students' expectations of final grade and perception of workload were reported to be similar to other courses in which they were enrolled. In Treatment Group I, computer tests using ASCII displayed text, students reported a heavier workload than in other courses and the anticipation of a correspondingly higher grade. Students in Treatment Group II, computer tests using Telidon/NAPLPS display, reported the expectation of higher grades but the perceived workload was reported to be similar to that in other courses. Objective measures of number of test attempts and machine time for both treatment groups indicated Treatment Group II did not differ in workload from Treatment Group I. Herrmann concluded that the nature of the computer display in this study did make a difference in student attitude toward the workload in the course. He has suggested that the Telidon/NAPLPS format may contain some intrinsic motivational value in that as students worked with the material they were not directly conscious of the passage of time. This raises interesting areas for research in the design of computer messages. The differences between ASCII display and NAPLPS may be analogous to the differences in printed text between typeset material and word processor output of a dot-matrix printer.

In other survey in the four courses included in the pilot study, students reported on the sometimes slow response time to their inputs and the inflexibility of the system to interpret their responses which were correct in concept but misspelled. They also complained that some test items appeared before they had studied the material in class. There was some frustration that wrong answers or unacceptable responses were judged but not corrected.

Some of these difficulties were related to the limitations of the long distance communication lines operating at 1200 baud or the fluctuating demand on the host computer by the major Grassroots users resulting in variable response time. Other more serious limitations related to the instructional decisions incorporated by the instructor such as the sequence of test items and the handling of incorrect responses.

The pilot project indicated that while the system offered promise, there was a need to improve the technical aspects, especially the slow response time. It also revealed the need to concentrate on instructional design factors. The major conclusion was that a Telidon/NAPLPS system could be used effectively as an instructional vehicle but that a lower cost microcomputer based system should be investigated and that an instructionally oriented authoring system was needed to overcome the limitations of available Telidon/NAPLPS data base software. In conjunction with Tayson Information Technology Inc. of Toronto, the project team began, in spring 1984, the task of designing and writing software to operate on the IBM-PC system or on compatible work-a-like equipment. The goal was to create a versatile interactive teaching and learning system (VITAL) on a microcomputer.

The objectives adopted in designing VITAL were as follows:

(a) To implement Telidon/NAPLPS with its high quality computer colour graphics and text on a microcomputer;
(b) To create a system which could be used by teaching and support staff who were not computer programmers;
(c) To combine the essential elements of content creation, instructional programming, content presentation and record keeping into one integrated software package;
(d) To provide a system which would be open to a number of variations in the way material could be handled for courses of different levels and with different instructional design parameters;
(e) To provide a system with a low entry cost in terms of equipment but which could also grow in capacity to support 20 or more simultaneous users on a local network (Moore, 1985b).

VITAL: AN EMERGING TELIDON/NAPLPS MICROCOMPUTER-BASED LEARNING SYSTEM

VITAL exists now as an integrated videotex course authoring system which enables instructors, teaching assistants and media personnel with little, if any, computer programming skills to produce colorful text and graphic learning materials on low-cost microcomputer equipment. The system uses the IBM-PC as the basic equipment building block to which a hard disk, network capability and a variety of student terminals may be added. Initial Telidon equipment was costly and purpose specific. Subsequent developments by Norpak, Microstar, Microtaure, FBN software and IBM have resulted in increased capability for the microcomputer through the use of colour graphic cards and software decoders. With these additions the micro can function as a NAPLPS terminal or study station.

The instructional application called VITAL bears little resemblance to the Telidon of the early 1980s. Careful observers of that day recognized that Telidon was not a specific type of equipment or application but essentially a new and efficient way of encoding graphic material for storage and display in a computer. If one accepts that as the essence of Telidon and its more recent manifestation in NAPLPS, then VITAL is a form of Telidon/NAPLPS. However, since Telidon in the popular mind is equated with large databases and remote access over telecommunication lines, it may be more helpful to acknowledge the Telidon ancestry but see VITAL as a distinctly different application.

VITAL, like its earlier Telidon antecedents and other application software packages uses a menu approach to provide straightforward prompts to instructors in creating and programming materials as well as to students in using them. The functions of VITAL are accessed from a main menu which routes the user to one of four functional menus (Tayson, 1985).

Program Menus

The first menu is the *System Administration Menu.* The functions activated from this menu provide for the assigning of user access ID numbers and passwords.

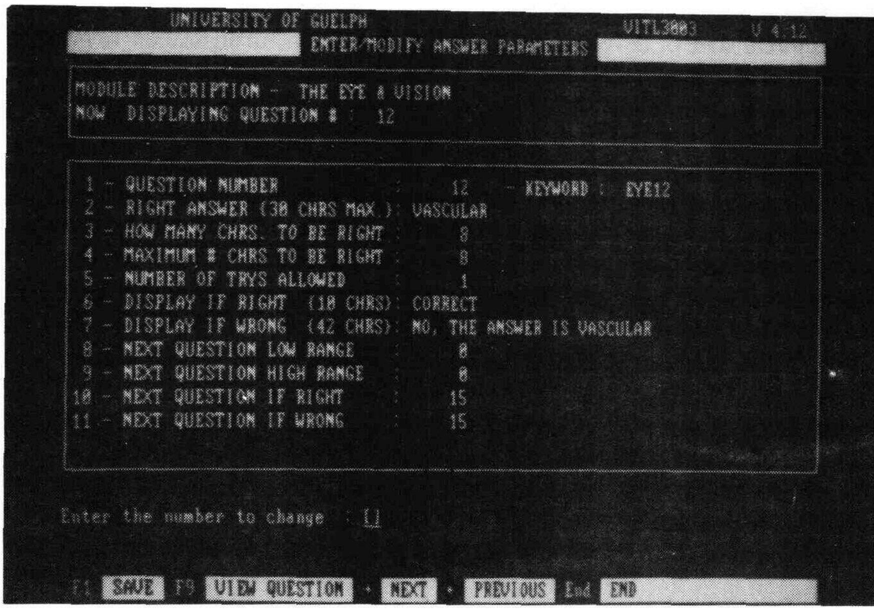
The *Instructor's Menu* establishes the instructional modules and sets the parameters for each module. It is also from this menu that the instructor programs the material by entering the appropriate information to the eleven parameters shown in Figure 5 (See next page).

Items 2, 3, 4 and 5 contain all the information required to register the correct response and to judge student inputs. Items 6 and 7 provide the initial feedback information to follow the judging feature. Items 8 and 9 specify whether the forward sequence will be linear or random. This feature allows for either a random selection within the entire pool of items or a block random selection within a designated area of the item bank. Finally, items 10 and 11 provide for either linear or branching paths. Each frame in the data base is assigned a reference (question) number, item 1, and each frame is programmed by using the "Enter/Modify Answer Parameters" function. While the commands are simple to execute, the eleven items combine to give considerable programming power.

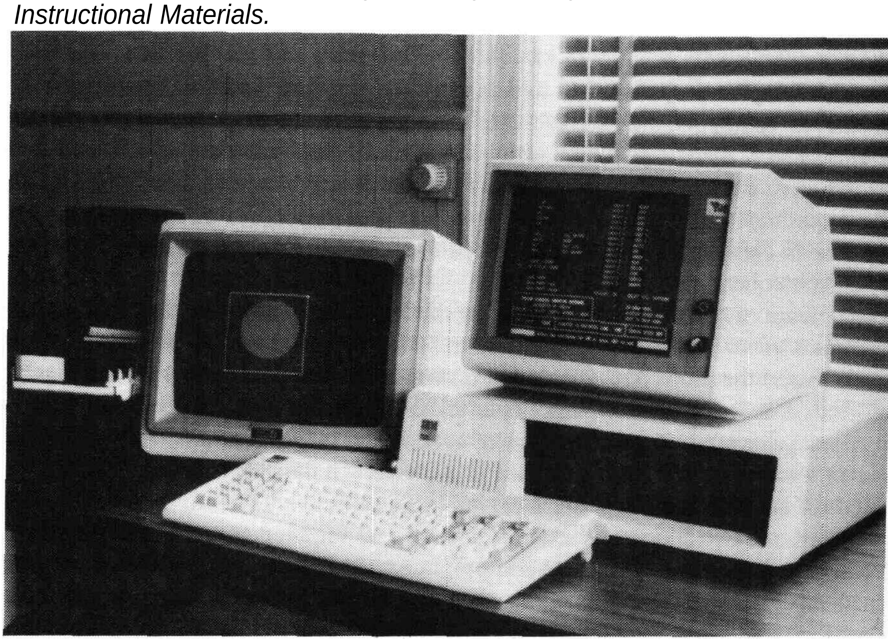
The Instructor's Menu allows the instructor to check the accuracy of the programming through the "Run the Module" function which emulates the student terminal display. This Menu also contains the commands to provide reports of individual student performance or summary reports of the class activity.

The third menu is *Module Administration* and it is here the individual instructional frames are created. This is achieved by using the Frame Creator function. The instructor's work station shown in Figure 6 is an IBM-PC equipped with a Norpak PCD6 card, a monochrome monitor and an analog RGB colour monitor.

FIGURES.
Menu for Providing the Instructional Program Sequences in the VITAL Modules.



FIGURES.
VITAL Workstation for Creating and Programming Instructional Materials.



The monochrome monitor displays the graphic, text and colour choice menus. It allows the operator to track and alter the status of the currently active functions. The colour monitor provides an immediate display of the visual elements as they are being assembled.

Editing of text is achieved through a Text Editor.

The fourth and final menu is the *Presentation System Menu.* This sets up the software to allow students to access the modules and activates the session level record keeping of all student transactions.

At the current state of development VITAL does not contain algorithms to generate problems or to effect simulations. It is limited to handling material which can be specified in a predetermined manner.

Implications for Instructors and Other Outcomes

Prior to the pilot study very little direct evidence was available at Guelph of the impact on faculty workload in creating course materials for such a system. What was available was information from other studies on the need for highly skilled computer programming specialists (Jones, 1984; Sparkes, 1984) and estimates of the time required to create 1 hour of instruction ranging from 100 to 500 hours of preparation time. Hofstetter (1983) placed a cost estimate on this activity of $2,500 per hour for uncomplicated tutorial material without judging features to $8,000 per hour for simulation material. Hofstetter reported that the time commitment at the University of Delaware to create 1 hour of instruction of PLATO required 76 hours of designer (instructor) effort plus 120 hours of programming time. Bates (1984) suggested that this time cost could be reduced by "more sophisticated authoring languages making it easier for teachers to write material for CAL." At Guelph, apart from the pilot study, unless an instructor was accomplished in programming or had access to computer programmers, the use of computers for instruction was an elusive dream.

The reality for most faculty members is that their teaching load is a recurring activity with very few opportunities to invest the heavy "front end load" required to create, test and evaluate alternate resource based learning approaches. This includes the necessary time to acquire enhanced instructional design skills. While equipment acquisition is relatively easy, the essential requirement to acquire instructional design skills, time and support, generally is in short supply.

The Guelph pilot project sought to determine the extent to which a user friendly system such as Telidon/NAPLPS could ease the entry of faculty members into an exploration of alternatives. Since everyone, faculty and support staff, was learning the procedures for the first time, a relatively steep learning curve prevailed. Materials were produced in modules requiring 10-20 minutes of student contact per module. It was found that the investment of time in creating the first module drops to about one-third by the completion of the fourth and subsequent modules.

The amount of preparation time spent by the four faculty members in the pilot study ranged from 8 hours per hour of student use to 54 hours with a median of 30 hours. Four instructors joined the project after its initial phase and have reported time investments ranging from 4 hours per student study hour to 30 hours. In five cases the faculty had teaching assistants whose time commitment, in addition, range from 8 hours to 104 hours per hour of instruction. Centrally provided support staff in the Telidon Page Creation Centre accounted for an additional 10 hours to 90 hours per student study hour with the median being 50 hours. In two courses no external support was required apart from initial training of the teaching assistants who created and programmed all the instructional materials. The combined experience of the eight instructors to use the system to date suggests a reasonable estimate of 22 hours instructor time spent in planning, preparation and evaluation of the materials for each hour of student study once familiarity with the system is achieved. In addition, 50-60 hours of support staff time are required for each hour of student study time. Individual cases, however, range from a low of 4 hours instructor/8 hours support staff to a high of 54 hours instructor/194 hours support staff. In the latter case this was the first course undertaken with an exceptionally high learning curve. While these findings confirm that considerable time and effort are required to create computer based learning materials, this time investment is about one-third that reported in the literature on preparing computer based learning materials (Hofstetter, 1983).

Interviews with seven faculty members in the fall of 1985 revealed that all but one considered the project to be advantageous. They reported such things as "it satisfied my curiosity," "it appealed to students," "it forced me to update the course and improve its quality" or "raised the value of the faculty/student contact time in class." In other developmental projects at Guelph, faculty similarly report the primary value not to be the specific materials produced nor media used but the enhanced grasp gained of the learning process itself. Since few faculty members are trained as teachers this is an important outcome. In the search for improved teaching and learning practices the use of a system such as VITAL provides an opportunity for in-service training in instructional principles.

Recently an institutional cooperation agreement between the University of Guelph and Sukhothai Thammathirat OPEN University, Thailand has selected VITAL for a pilot study as an additional delivery vehicle in the latter's distance education system to 400,000 adult students. A training session in December, 1985, for 16 academic staff and 8 technical staff demonstrated the speed with which basic VITAL courseware skills can be acquired by those unfamiliar with computing equipment. At the conclusion of an eight day training workshop four course teams comprising four faculty and two support staff had each created an interactive, highly visual, tutorial package of 10 minutes duration. The disciplines selected were mathematics, basic science (two courses) and economics.

CONCLUSION

The University of Guelph's pilot study of videotex as a viable educational medium has provided promising findings of student acceptance in terms of both its use and the quality of instructional materials carried on it. It has found growing acceptance among instructors for the quality of teaching materials which they can create without previous computer language or programming skills. The experience of the pilot study with a large minicomputer and network communications led the project staff to design and implement a microcomputer based versatile interactive teaching and learning system using Telidon/NAPLPS.

VITAL exists as one more tool in the kit of teachers and instructional designers. It offers an integrated computer based learning system capable of producing highly visual instructional material. These can be used in tutorial packages which allow for self-paced independent study and which can give students frequent practice and feedback.

No one medium is a panacea. A number of years ago a Canadian scholar, Ted Sheffield (1974), studied the practices of outstanding teachers. He was led to the conclusion that there is no one way to teach. There are a number of ways, some better than others, but essentially it is a matter of good instructional design and the application of good learning theory.

The intent has been to make VITAL plastic and flexible so that it can support good instructional design. The answer to improved effectiveness and efficiency of our teaching efforts does not lie in the tools we create but in the purposes to which we apply those tools. VITAL is one such tool but the creative and effective applications will come from teachers and instructional designers with a commitment to helping people learn. It is this concern for the outcomes of instruction which is urgently needed in an environment which is largely technology driven. Balcovich, Lerman, and Parmelee (1985) have observed that "universities have often simply accepted the specific technologies of current hardware and software before asking how they might use them."

REFERENCES

Alpert, D. & Bitzer, D. L. (1970). Advances in computer-based education. *Science 167,* 1582-1590.

Balcovich, E., Lerman, S., & Parmelee, R. P. (1985). Computing in higher education: The Athena experience. *Communications of the ACM, 28* (11), 1214-1224.

Bates, A. W. (1984). New Communications technology and distance education: Implications for commonwealth countries of the south. *Papers on information technology* (No. 239). Milton Keynes: The Open University.

Digital Equipment Corporation (1984). *Introduction to computer-based education* (2nd ed.). Billerica, MA: Digital Press.

Herrmann, T. (1984, August). *Telidon as an enhancer of student interest and performance.* Paper presented at the annual meeting of the American Psychological Association, Toronto.

Hofstetter, F. T. (1983). The Cost of PLATO in a university environment. *Journal of Computer Based Instruction, 4,* 148-155.

Jones, A. (1984). Computer assisted learning in distance education. In A. W. Bates (Ed.), *The role of technology in distance education* . London: Croom Helm.

Leppmann, P. & Herrmann, T. (1982). PSI, what are the critical elements? ERIC Document, (Report No. ED 214502).

Moore, G. A. B. (1985). Videotex (Telidon): Its potential and problems for traditional and distance education. *Canadian Journal of Educational Communication, 14* (1), 10-26.

Moore, G. A. B. (1985, December). *VITAL: A videotex integrated teaching and learning system for education and training.* A paper presented at the ASAIHL Seminar "Communication Technologies: Implications for ASAIHL Universities," Association of Southeast Asian Institutions of Higher Learning, Bangkok.

Pylyshyn, Z. (1984). What about instruction? *Western Ne\vs,* p.5.

Rogers, E. M. (1983). *Diffusion of innovations: A cross cultural approach* (2nd ed.). New York: The Free Press.

Sheffield, E. F. (1974). *Teaching in the universities: No one way.* Montreal: McGill Queen's Press.

Sparkes, J. (1984). Pedagogic differences between media. In A. W. Bates (ed.), *The role of technology in distance education.* London: Croom Helm.

Tayson Information Technology Inc. (1985). *VITAL operation manual* (Version 4). Toronto: author.