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An Application of Personalized Instruction to Remote Sensing Technology

by

S. M. Davis and J. C. Lindenlaub

Abstract

This paper describes an application of personalized instruction to the training of people using a computer network dedicated to remote sensing technology. It describes the educational challenge posed by the kind of learner to be trained, the instructors available, the physical and administrative conditions, and the rapid evolution of the technology being taught. The LARSYS Educational Package, a 6-module, multi-media sequence developed to meet this challenge, is described in detail. An evaluation of its effectiveness is included.

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Introduction

Personalized instruction is currently gaining wide acceptance in many college disciplines as a way to effectively educate people of varied backgrounds and learning rates, but it is also finding a place in the training of people not enrolled in programs of formal instruction. Reported here is an application of personalized instruction to data analysis, specifically analysis of remote sensing data through the facilities of a computer network accessing a unique software package. This educational program, designed on the principles of mastery learning, uses an effective blend of several instructional media to give adults the skills and understanding they need to carry out data analysis tasks.

I. The Challenge

In 1970, NASA approved and funded at Purdue University's Laboratory for Applications of Remote Sensing (LARS) the establishment of a computer network for the analysis of remote sensing data. In large measure, this remote terminal project is educational in nature: it aims to provide a rapid way to disseminate

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the evolving remote sensing technology to users across the country. LARS has for many years been training Purdue students and staff members in the particular data analysis methods developed there, but now, with the establishment of the remote terminal network, this educational function has become much broader. Literally hundreds of people new to the system need to become familiar with the theories supporting the analysis procedures and need to be trained in the use of the hardware and software available. It has been these needs that have led to the development of the educational package described in this paper.

To fully characterize the specific educational challenge, we must look at a few other factors: first, the diversity of student expected and, second, the limited time and experience of the people who would be available to serve as instructors. The potential "student" fits into no single category; he might be a university undergraduate going data analysis as a part-time job, or he might be a highly trained engineering geologist employed by a state highway department to improve highway configurations. He might be freed from his other duties to proceed through an educational program as a full-time learner, or he might have only a few hours a week to devote to this work. He might be working alone or as part of an analysis team.

It has further been expected that while the "instructors" are thoroughly compentent data analysts, they may not be gifted,

or even experienced, teachers. In most cases they are people who themselves have only recently been "students" in the program and now are becoming helpers or "proctors" for their colleagues while continuing to carry on their own research. These learner and instructor factors were significant in the decision to design educational materials for individual study. The student needs to be free to progress at his own rate but without the frequent intervention of a highly trained instructor.

Two other considerations were important in the designing of the educational materials, one a factor of the administrative relationship between LARS and the remote terminals and the other a result of the rapid development of remote sensing technology. For a clearer picture of the remote terminal situation, let's look for a minute at the components of the remote terminal network. The heart of the remote terminal system is an IBM computer consisting of a central processing unit, several storage devices, tape drives and a control unit for supporting the remote sites. At each remote site, terminal equipment includes a typewriter, a line printer, and a card reader/punch, all connected to the central computational facility by voice-grade telephone lines. At the present time there are six such remote terminal sites in operation: at Purdue University; Old Dominion University (Virginia); the state capitol offices in Austin, Texas; and at the NASA installations at Wallops Station (Viginia), Goddard Space Flight Center (Maryland), and Johnson Space Center (Texas). The software available to the remote terminal users is provided

by LARSYS (Phillips, 1973), a data handling and analysis system designed and documented at Purdue University specifically for use in analyzing multispectral scanner data.

As a part of the agreement between LARS and the remote site personnel, the remote users agree to train their staff by using the LARSYS Educational Package, but once these educational materials are sent to the remote sites, their intended use can only be described and not prescribed. As might be expected, the way of using the educational materials varies with the facilities and administrative priorities at each site. And so for the users to master the data analysis procedures, the educational materials need to be adaptable to these widely divergent conditions. And for the remote terminal system to function efficiently, it is essential that analysts be well-trained in the use of the processing functions.

The rapid evolution of remote sensing technology also needed to be planned for. Since data analysis research is an on-going program, repeated refinements and improvements in the data processing software are anticipated, and any changes affecting the user need to be incorporated promptly into the educational materials, those on hand as well as those already distributed. This need for periodic revisions had to be considered also in the initial design.

And so, to sum up so far, that has been the educational challenge: to provide a means for geographically scattered adult students, with widely varying backgrounds and needs, to learn how

to use effectivley a specific data analysis procedure and to learn it in a situation where neither highly skilled instructors nor analysts with extensive experience might be available to help. On the other side of the ledger are the happy facts that there is no school calendar to consider, no formal curriculum requirements, and no grades to be given.

Interest in remote sensing technology is growing rapidly and so materials to train new users have been needed quickly. The uniqueness of this particular task meant that there have been no models to draw from nor has there been time for extensive field testing. Educational research conducted both at Purdue (Postlethwait, 1969) and nationally has provided the approaches needed to meet this challenge.

II. The Product

The product designed draws greatly on the audio-tutorial methods of personalized instruction and contains many of the features of Keller's Personalized System of Instruction (Stice, 1971). The LARSYS Educational Package, as it is named, consists of a series of six mini-courses, each designed to take a student from an initial point, defined by the prerequisites of the mini-course, to an end point defined by its instructional objectives. The student progresses in a linear manner through all six mini-courses, each of which provides a mechanism for information transfer, an opportunity for the student to practice or study

the skills or ideas presented, and a problem or test situation where he can determine **whether** he has met the instructional objectives.

A wide variety of media is employed in the Educational Package, the selection dependent on the nature of the material and the objectives of the unit. Media used include a programmed test, a slide/tape presentation, a live demonstration, operation of a remote terminal, and practice in doing analyses through exercises and an extended case study. The aim has always been to choose a medium which allows the learner to experience the real analysis procedure as fully as possible.

The first unit, entitled the Basic Preparation, follows the format of a programmed test. The specific purpose of this unit is to provide a common background to students who expect to make use of the LARSYS data analysis software system, to acquaint them with the basic concepts and introduce them to terminology used later on. Since students vary in their previous experience with remote sensing, in this unit each may plot his own course through the 90-page book, reading only those sections containing materials unfamiliar to him. Frequent self-tests help him in these decisions. Typically students spend from one to six hours on this unit, and average about 2 1/2 hours. The second module is designed to give the student a quick, one-hour overview of the software capabilities of LARSYS and an opportunity to follow, step-by-step, through a typical analysis. Since the objective

of this unit is to help the student gain an overall picture, the medium used is an audio tape supported by illustrations which are available either as slides or in a flip-chart/notebook format. While a student may stop the tape recorder to take notes or to listen to any section of the tape again, this medium was selected because it tends to encourage students to let the minute details to by in favor of gaining a broader perspective.

The next two mini-courses are designed to acquaint the student with the data processing hardware available to him at the remote site where he is working, and to this end the remote terminal is the "medium" used. The student working on Unit 3 witnesses a demonstration of the typewriter, card reader/punch, and line printer by an experienced LARSYS user and has an opportunity to see several jobs run. He leaves the demonstration with a sample output from the line printer in addition to pre-printed student notes. The "hands-on" experience, which is the core of the next unit, gives the student a chance to use the terminal alone. Listening to an audio cassette tape through head phones, he does as the tape directs him, obtaining the list of instructional objectives by using the card reader and continuing this self-guided work for an average of three hours. He runs sample LARSYS jobs, transmits data to and receives data from the main computer. The audio tape is also supported by a detailed set of written notes for the student to use and keep for future reference.

In the final two units of the Educational Package, the student, now familiar with the underlying concepts of remote sensing and with the operaton of the remote terminal, can begin using the LARSYS processing functions and study the analysis method in detail. Unit 5 contains six short exercises done at the terminal which, when completed, give the student more familiarity with both the nature of the data being analyzed and the processing functions available through LARSYS.

The last component of the instructional sequence, entitled Guide to Multispectral Scanner Data Analysis, provides a detailed description of the analysis process and helps student achieve mastery of the eight analysis steps through a carefully developed sequence of study and activity. The student can read about the theory behind each step, study an example, test his understanding by doing the exercises, and finally carry out the parallel step in a case study analysis. This last mini-course is by far the most time-consuming with most students spending 20 to 30 hours on it.

Though the student is to a large extent self-guided as he works through the modules, the success of his experience depends on his interaction with an instructor-consultant who is readily available to him. The function of the instructor-consultant is not to plan and preside over formal classroom sessions but rather to serve as a tutor or proctor helping to clarify troublesome

points for the student. To aid him Instructor's Notes are available which list the instructional objectives for each unit, the equipment needs, additional technical information, and suggestions on how he might best work with the student. With the exception of the Demonstration Unit where the instructor has a central role to play, the approach stressed is that a student's sessions with his instructor should be brief with the instructor providing the necessary corrective feedback or encouragement to enable the student to continue on his own. On-going consultant help is also available to the instructors from LARS.

III. Evaluation

The present version of the LARSYS Educational Package, which has been in use since October, 1973, has elicited very positive comments from both learners and their instructors, as well as from people such as project coordinators and techniques specialists who are more concerned with the level of mastery the student achieves than with the quality of his educational experience. In the Unit Questionnaires, students tend to praise especially the step-by-step method used to explain complicated procedures. Many of the students have never used a computer before they start this educational program, and after about 40 hours of study and practice, they finish the work confident in their ability to channel the computer's powers to meet their own needs.

In view of the fact that the instructors are, first of all, data analysts "borrowed" from their other duties, we have been especially interested in knowning how they feel about the time

they spend with students on the Eduational Package. Those responding to this question have been quite satisfied with this aspect of the design. The fact that their discussions with students are short means that they can monitor a student's progress without having to set aside major time segments from other obligations. Further, from their experience they fully endorse personalized instruction as the way to train students in this kind of technology.

This positive reaction to the LARSYS Educational Package is not meant to indicate that it is beyond improvement. Both learners and instructors have had suggestions to make about the clarity of the material, the effectiveness of the various media used, and the instructional objectives of the unit. For example, one interesting media problem recently came to our attention through the student evaluations. The "Overview" in Unit 2 initially been planned as a series of 135 slides accompanied by a 45-minute audio cassette tape. In order to make the material more available to students who might not have easy access to a slide projector, a flip-chart type notebook was developed as an optional format for studying the figures. The result was that the instructional unit which had initially been a rapid-fire, attention-getting slide sequence degenerated into fumble-thumbed page turning, and the student criticism was justified.

Another significant criticism, this time from instructors, is that the self-tests included in the Basic Preparation don't

always give the novice the satisfaction of knowing that he has achieved an adequate understanding of the material. In this case hindsight has been our ally. When we looked back at the questions, we found, for example, a request that the student give a five-minute description of a fairly complex data-gathering instrument with no environmental conditions other than that he has a diagram to use. It is questionable whether many students would even try to test themselves in this way unless it were demanded of them by the instructor. In response to the student and instructor feedback, the six mini-courses are continuously under review; every suggestion or correction is rated as to its validity and urgency and then incorporated into the revision scheme.

Other on-going revisional needs come as a result of the rapid advancement in remote sensing technology itself. While the theoretical foundations for the data analysis system will probably not change significantly, many of the procedures may. To meet this problem, periodic reviews, revisions of and additions to the educational materials are carried out which, while extensive in nature, do not often necessitate a thorough overhaul of the existing material. The modular design for the materials has indeed proved a benefit in easing these revision problems.

LARS' educational commitment will be expanding as an increasing number of potential users express interest in LARSYS and in

accessing the data bank and software through the remote terminal system. Transferring an understanding of this new, evolving technology is no small challenge, but the flexibility and mastery possible through personalized instruction have been major factors in the successes enjoyed so far.

References

Phillips, T. L. (editor). 1973. LARSYS User's Manual. West Lafayette: Purdue University.

Postlethwait, S. N., J. Novak, and H. T. Murray, Jr. 1969. The Audio-Tutorial Approach to Learning. Minneapolis: Burgess Publishing Company. (Second Edition)

Stice, James E. (editor). 1971. The Personalized System of Instruction: The Keller Plan Applied in Engineering Education. Austin: The University of Texas.

The LARSYS Educational Package

Title: Remote Sensing Analysis: A Basic Preparation
Summary Objectives: Vocabulary building, orientation to remote sensing principles and pattern recognition ideas.
Study time estimate: 4 hours

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Title: The LARSYS Software System - An Overview
Summary Objectives: Orientation to software capabilities and following thru a typical analysis sequence.
Study time estimate: 2 hours

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Title: Demonstration of LARSYS on a 2780 Remote Terminal
Summary Objectives: Orientation to terminal hardware, terminal procedures. Study program output.
Demonstration time estimate: 1.5 hours
Study time estimate: 1 hour

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Title: How to use the 2780 Remote Terminal-A "Hands-On Experience"
Summary Objectives: To transmit cards, receive punch and printer output, run a LARSYS program when given the control card decks.
Preparation time estimate: 1.5 hours
Estimated time at computer terminal 2 hours

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Title: LARSYS Exercises
Summary Objectives: Practice in using the terminal, writing and executing simple LARSYS programs.
Time estimate: 6 hours

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Title: Guide to Multispectral Data Analysis Using LARSYS (with accompanying Example and Case Study)
Summary Objectives: Analysis sequence philosophy, a detailed example and an analysis case study.
Study time estimate: 10 hours
Case study time estimate: 20 hours

A flow chart of the LARSYS Educational Package giving the title, summary objectives and time requirement estimate for each unit.