Teaching's Third Dimension

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Reprinted from SCIENCE, Vol. 163, pp. 127-129, 10 January 1969.

Pitzer's article ("University integrity," Science, 11, Oct., p. 228) focuses in part on the critical dimension of student-faculty relationships. The faculty role is depicted as composed of two factors – teaching and research, not necessarily in that order of importance. I would like to emphasize a third equally important charge of the faculty member – that is, the role of personal and educational counselor and adviser to the student. Any professor who is reasonably accessible personally and geographically will attest to the frequent, almost continuous, and apparently very important student-to-professor counseling sessions on every subject from personal problems to specialized career planning.

This third dimension is so much a part of the professional job that it is hard to question its appropriateness. Those who do, even in the glaring light of the present student unrest, should be reminded that advocates of good educational practices have long stressed the importance of interpersonal relationships as the basis for meaningful behavioral change – a basic goal of education. Even some of the more ardent proponents of technological aids to instruction (for example, Skinner[1]), support their positions with the observation that these aids will free the teacher to increase the personal component which no device, save the human, can accomplish. These interpersonal relationships have the greatest impact on the emotional concerns of the student and also support the cognitive or intellectual change we expect. Even the most formal method of instruction, the lecture, has been considered most effective when it serves this emotional component[2]. The professor as counselor and adviser serves this emotional factor even more, it seems, in the many spontaneous sessions that occur as an informal part of his job.

In meeting the exhausting demands of this third personal factor, the crux of the problem of higher education becomes not the integrity of the university, but the integrity of the professor. Even in his reluctance to recognize and label this dimension to his role, he will quickly note that there is little if any official reward for his counseling activity, either by his colleagues as they rate him as a professional and scholar, or by his institution as it defines his task. However, one observation is clear – the students' conception of education recognizes this, as evidenced by its frequent use, as a useful and necessary component of that experience.

REFERENCES

1. B. F. Skinner, The Technology of Teaching (Appleton-Century-Crofts, New York, 1968).
2. L. Bragg, Science 154, 93 (1966).

Computerized Hydrologic Data Acquisition System – A Facility For Upgrading Instruction In Watershed Management

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INTRODUCTION

Technological explosion, population expansion, urban sprawl, changing patterns of land and water use and increasing emphasis on environmental quality control are presenting vast new challenges to natural resource scientists and land managers. To successfully meet these challenges, colleges and universities need to produce graduates with new kinds of training and skills. Land managers of the future must have a wide understanding and have a technical training much better than ever before. Familiarity with the computer, for example, is no longer so much an advantage as a necessity. Similarly, skill in interpreting remote satellite data for land management purposes may be required in the very near future. Accordingly, the Department of Watershed Management in the College of Agriculture of the University of Arizona has an extensive program of upgrading its curriculum and improving teaching methods. The purpose of this paper is to describe a teaching-research facility which provides an innovation in instruction techniques for one facet of the program.

THE FACILITY

The facility is a completely interfaced hydrologic data acquisition processing system. It goes somewhat beyond the definition of SCI and CDI as described by Borden.[1] In addition to a small, laboratory computer and the services of a remote time shared terminal to the large CDC 6400 computer, the facility also includes both software and hardware for working with live telemetered data. Provisions are also made for the rapid recall of past data from a magnetic tape library.

The complete facility consists of a forested mountain watershed about 55 kilometers and three desert watersheds about 75 kilometers from campus which are instrumented with electronic sensors for measuring a large variety of hydrologic and meteorological variables. Measurement data are multiplexed over the Bell Telephone system to a laboratory on campus. The laboratory computer which is incorporated into the system, processes the raw data on-line, producing finished answers in any format desired. It also affords the user total control of the data taking process – varying the sample rate in relation to input changes, real time, etc. All output is recorded on tape but may also be displayed on strip charts or teleprinter.

The facility including data reduction schemes, operational computer programs and laboratory exercises is about 75 percent complete at present. Because it is open ended to allow addition or deletion of developments in instruction techniques, its full capacity will probably not be realized. It is being tested in several courses this spring and will go into full time operations next fall semester.

Experimental watersheds associated with a teaching and research program of a college is not a new idea. However, those schools with such facilities still depend largely upon time consuming traditional methods of data collection and compilation. The compilations which are usually made to facilitate specific types of analysis lack versatility. At best the traditional watersheds serve the student for occasional fair weather trips when significant hydrologic events are not occurring. They may also provide historic records from specialized research for retrospective examinations.

The present facility is extremely flexible and unifies the entire process of data collection, compilation and analysis into a single unit. By means of high speed computation it offers the possibility of having data collected, reduced and analyzed in any desired fashion almost immediately and in some cases while the hydrologic event is occurring. The student is able to observe and work with hydrologic processes in the laboratory, at any time and under the most inclement conditions.

With this versatility it offers an opportunity to lessen the gap between the publication of research results and their eventual incorporation into classroom instruction. Because of the convenience of having a variety of data immediately at hand and ready for the computer, new developments in hydrologic techniques and research can be tested and demonstrated with the facility as they become pertinent. Teaching efficiency and educational effectiveness is increased by dealing with complex problems in a very practical but dramatic way.

The small digital computer offers educators an economical means of teaching the application of computer principles and programming, ranging from basics to the implementation of senior student projects. Although FORTRAN is the primary language used in upper division courses, the ability of the computer to use BASIC makes learning easier at the lower levels.

Aside from an inherent research function, the entire facility serves as a laboratory for student instruction. The specific instructional objectives of the facility are to give students: 1) A fundamental understanding of the interrelationships between variables in the hydrologic cycle by working first-hand in the laboratory with these quantities as they actually change in space and time on natural watersheds, 2) Technical training by performing laboratory exercises in computer programming for data reduction and analysis, 3) Practical experience by working first-hand with a complete hydrologic facility employing the latest developments in instrumentation, 4) Preparation to qualify for further academic training in hydrologic modeling of watersheds and in systems analyses for managing lands for the optimum production of water.

The faculty participating in the project has been encouraged to develop teaching programs which exploit the facility. It is presently being tested at three course levels, each of which employs a different strategy.

USE OF THE FACILITY

Introductory Courses

The facility will be useful this fall at the freshman and sophomore level to stimulate interest in the quantitative aspects of watershed hydrology. It functions as a live demonstration to point up some of the physical processes operating on natural watershed areas, the associated technological management problems in resource use and the implications of sociological demands. CSI which employs canned programs is used both with the small laboratory computer and with the time shared terminal to the large computer. The laboratory computer and its associated hard and software, telemetry system and sensors is used to demonstrate modern automatic methods of data acquisition, compilation, reduction and storage. Synthetic hydrologic model programs are selected through the time share terminal to simulate the effects of land management practices on water values. Because these models simulate most of the major hydrologic processes as well as their aerial and temporal interaction, the instructor can simulate and demonstrate the effect of a great variety of land management practices.

Intermediate and Graduate Level

The facility is used by juniors and seniors for problem solution, data reduction exercises and hydrologic modeling. To provide maximum use of the facility the laboratory is scheduled not only for the normal class day but is also open to the students involved on evenings and weekends. Five courses will be using the facility during the coming academic year.

It will be used in a basic hydrology course principally to provide reliable data and computational facilities for problem assignments. Typical problems include unit hydrograph analyses, mean basin precipitation calculations, infiltration determination by hydrograph analyses and precipitation probability calculations. Because many of these problems do not require a great amount of computer storage they may be run on the small computer by time sharing with its normal functions of data gathering and processing. Since this function requires only part of the computer capacity, problems are solved rapidly and students can quickly debug their programs by repeated re-runs.

Digital simulation of hydrologic processes which permit the student to vary the parameters and observe the response quickly have added a new dynamic dimension to the teaching/learning process. For a senior course in watershed management a series of programs are being prepared which are mathematical representations of the major hydrologic processes operating on natural watersheds. Problem exercises developed for the programs greatly simplify the description and explanation of complex hydrologic interrelationships. For example, to provide a meaningful experience with a complex hydrologic process for the unsteady transient conditions found in nature, the student has a choice of several models for each of the major hydrologic processes, e.g., snowmelt runoff, evapotranspiration/antecedent storage/runoff, precipitation/interception, solar energy/evapotranspiration, infiltration/runoff, etc. He must fit the mathematical functions called for in the models with basic data retrieved from the tape library or collected concurrently. Computer programs for fitting some of the more complex functions are also available. The functions are applied to the models in such a way that the student may vary parameters, for sensitivity analyses, evaluation of applicability of various models, or observation of the effects of hypothetical watershed management treatment on the processes.

The facility is to be used at the graduate level to aid instruction in hydrologic simulation methods. A major function will be to supply graduate students with field study areas, reliable data and the latest scientific equipment for handling significant research projects.

Applicability to Remote Sensing

Remote sensing of our environment is one of the most rapidly advancing technologies of the space age. Reliability is increasing and costs decreasing. The impact on natural resource management in the future will be considerable.

At all instruction levels the use of the facility for instruction in the rudiments of remote sensing is emphasized. Because of the flexibility of the facility many new developments in remote sensing can be readily adapted and because it is an integral part of an active research program in this area, the student can be kept keenly aware of the advances being made and their applicability to natural resource management.

Acknowledgements. This project is partially supported by the Agency for International Development under an institutional grant to increase instructional competence in system analysis of watershed management.

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[1]Borden, F. Y. The Use of Computers in Education in Colleges of Agriculture and Natural Resources. The Journal of the Nat'l Assoc. of Colleges and Teachers of Agriculture, Vol. XII, No. 2, June 1968. pp. 34-38.