Getting an on-line departmental teaching laboratory on-line

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The major problems faced in building a department-wide undergraduate, computer-based teaching laboratory are discussed: selling the concept of the "ultimate dry lab," assembling the hardware, motivating and rewarding faculty and staff effort, devising a systems approach for curriculum design, and program evaluation.

During the past few years, the University of Florida undergraduate psychology laboratory has evolved from one using computer modeling and simulation techniques in cognitive psychology to a facility for teaching personality and experimental analysis, as well as sensory, social, developmental, and biopsychology. Our original aim was to create with microcomputers a poor man's PLATO, but as Fischler (1980) and White (1980) show, we have done considerably more than would be feasible in PLATO, and at far less cost. My aim is to share some "first principles" to consider in developing a facility to handle some or all of the departmental needs for instructional laboratories.

Developing a facility and new curricular materials that can support a large and diverse teaching program involve considerations different from creating a laboratory for your own use. You can put a terminal in a closet, provide for instruction on your research computer, and if the project doesn't pan out, the terminal can be moved back to the lab and the closet used again for storage. When many people are involved, however, the physical and financial arrangements become more complex, the professional relationships become more involved, and the initial decisions have more long-reaching consequences. This paper addresses five issues critical to the development and success of a large-scale project: how to establish and maintain faculty involvement, acquiring the needed local and external support, assembling the equipment, developing a coherent systems approach, and program evaluation.

STAFF INVOLVEMENT AND SUPPORT

The first order of business is building and sustaining faculty involvement. No one can succeed in motivating

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the faculty like a benevolent dictator, but this type of leader is rapidly becoming extinct. So if you cannot exert great power, and the powers-that-be cannot, either, then consider using the incentive plan we have tried successfully: a local guarantee of a summer salary to support instructional development exclusively.

Our experience has been that the creative juices flow best during the summertime, when there are fewer of the usual academic distractions to impede instructional development. But since an intensive summer is not always adequate to complete the job, consideration must be given to motivational mechanisms to use during the academic year. In research-based universities, where quality instruction is often given no more than lip service, the administration should be invited to put its money where its mouth is. Ask for sabbaticals, mini-sabbaticals, or genuine released time in the form of meaningful reductions in teaching loads. This can be sold to cost-conscious administrators if you impress them with the long-term savings that can accrue to these instructional approaches. And finally, alert the faculty to the indirect benefits that may result from additional citations on their vita and to the modest royalties that may be earned if their products have general utility.

OBTAINING ADMINISTRATIVE BACKING

Once the faculty are committed to the idea and appropriate mechanisms to support their work and to acknowledge their achievements are worked out, attention must be directed toward gaining the backing of the top local administrators. In the absence of a local ability to underwrite the entire program, a promise of at least a moderate economic commitment and a considerable display of enthusiasm must be secured if the project is to succeed at the major external agencies, especially the National Science Foundation (NSF). There are significant dollars at NSF for improvements in undergraduate courses and laboratories in psychology. Certainly, NSF appears to look with favor upon computer-related projects, for over 50% of their ISEP, LOCI, and CAUSE grants use computers in one way or another.

If we accept the axiom that university administrators prefer receiving to giving, then the problem of acquiring local backing reduces to demonstrating how the cost-benefit ratio of a major curricular change can be highly favorable to the institution. It should be easy to show how no new space would be required for a computer-based lab, for microcomputers can easily fit into most existing facilities. Indeed, if older, bulky equipment (e.g., three-channel tachistoscopes) will be retired, the conversion may produce a net gain of space for noninstructional purposes. If some use is made of a time-sharing remote megacomputer for instruction, it should be straightforward to project future savings in connect time, port charges, and CPU seconds by carrying most of the load in-house on dedicated machines.

Operating costs can be reduced if animal colonies do not have to be maintained for student use. And capital costs for future laboratory hardware can be minimized if the behavior of that equipment can be modeled or simulated. Personnel costs can be significantly less than a hands-on laboratory, owing to the fact that the time to set up and break down experiments and demonstrations is inconsequential in a computer-based laboratory. And finally, the purchase of microcomputers permits a great bang for the bucks. It is now possible to buy 5-15 fully equipped micros for the amount required 4 years ago for a minicomputer in the PDP-11/34 class. Buying redundancy for the classroom laboratory means that maintenance contracts and costly on-site rates for service can be forgotten. If a micro goes down, boards are swapped with another machine until the problem is located, and the defective board is sent out for repair at the lowest possible priority, getting the best possible rates. These matters all address potential cost savings, which can potentiate institutional benefits. Beyond these, there are important pedagogical benefits that can be distilled to the point that modeling, gaming, and simulations allow students to reach a greater depth of understanding for substantive matters and laboratory techniques as well as gain a broader perspective. These benefits arise from the tremendous reduction in time needed to get from an experimental hypothesis to data, and then to the next experimental hypothesis, as well as from the enrichment that results from exposure to the wide variety of paradigms that can be achieved only by the computer's capability to compress real-time.

SYSTEM ASSEMBLY

With a faculty waiting in the wings, and money within reach, thoughts must turn to assembling the laboratory. The consequences of the decisions at this point will have a major impact on the ease of developing and maintaining your curriculum, as well as the potential for its use elsewhere.

First, consider the entire system. Hardware is of little use without software, and software functioning depends greatly on an operating system. For example,

benchmark tests on a number of microcomputers revealed that there were enormous differences between extremely similar machines in the time needed to execute the same simple program; the ratio between the slowest and fastest was nearly 100:1. The cause was obviously due to differences in the construction of the operating system and the interpreter. The moral is that a shopping strategy centered on comparisons of machine cycle times is not especially meaningful.

Second, local needs should be the primary determinant of a programming language. But considerable consideration should be given to the possible use of your better materials by colleagues at other institutions. Select a language that executes more than quickly enough to support your present instructional needs to allow for uses not yet contemplated (for example, A/D conversion or graphics), as well as one that has the potential for execution on very different equipment with only minor modifications. Comparatively few microcomputers are multilingual. Virtually all support BASIC, but there are more than 50 dialects of that language, which differ in features, instructions, syntax, and file structure. Transportation problems associated with the multiple dialects of BASIC can be minimized by writing programs to CONDUIT standards. A selling point of many vendors is that their BASIC is stored in a read-only memory (ROM). This is terrific for them, because it reduces theft and the need to overprice software in anticipation of losses due to piracy. But it has a serious drawback for many of us: Namely, there is no way to enhance it. For example, if a ROM language package is delivered with no access to the system clock or no capability for linking to assembly language routines, then there may be no way ever to use the processor to collect reaction times. A new high-level language, PASCAL, may be the ultimate language of choice because it is machine independent, or nearly so, it is essentially self-documenting, and its compiler generates programs that execute very quickly.

Third, the viability of the manufacturer and vendor is a matter of utmost concern. The micro market is still growing, and so is the number of manufacturers. It is really not possible now to guess who will become the Packards and Studebakers of this industry. So in the absence of a crystal ball, look for obvious signs of quality and good workmanship, as well as compatibility of major parts. End-user manufacturers are primarily assemblers of parts made by others. If you can determine the source of major components in your vendor's package (especially the processor and the disk drive), you will still be operational if your vendor closes his shop, providing his supplier survives to provide compatible replacement parts.

A COHERENT APPROACH FOR INSTRUCTIONAL DESIGN

It is all too tempting for faculty and graduate assis-

tants to drop everything when the equipment is first plugged in and begin generating source code for their programs. Some languages, especially BASIC, make it exceptionally easy to generate programs as quickly as one can type. Unfortunately, the programs written in this manner are nearly impossible to modify later because their flow charts resemble a bowl of spaghetti. Moreover, faculty and graduate student resources are wasted if they continue to juggle conceptualizing and designing laboratory problems, writing student and instructor manuals, and generating program code all at the same time. A systems approach for courseware design and development has helped relieve us of some of these burdens. We ask the faculty to focus on problem conceptualization and preparation of documentation. Graduate assistants help in these areas, but they serve mainly as design analysts, conveying to student programmers what they understand the design problem to be. The programmers are responsible for writing code and program debugging, and their efforts are monitored by the graduate students and faculty to insure that the letter and spirit of the original concept is retained in the final product. Everybody has a defined turf and is free to let his or her creativity soar.

PROGRAM EVALUATION

Program evaluation is my final concern. I saved it for last not because it is something to be done after everything else is accomplished, but rather because it seems to be an intractable nemesis for so many involved in large instructional improvement projects. The very idea of evaluation of their instructional products disturbs many faculty, people who acknowledge the importance of evaluation in the world of scholarly research.

As few have had experience with program evaluation of instructional materials, they erroneously infer that the procedures resemble a journal's blind review, or worse, something akin to an IRS audit. I can assure you that a little education will go a long way toward allaying the apprehensions of participating colleagues. Neither the process nor the outcome has to be nasty, and the time spent on a data-based analysis is certainly time well spent. Indeed, several federal programs that support instructional development require a moderately sophisticated evaluation plan.

More important, we have a responsibility to our students, as well as to the students of others who may use our programs, to be able to describe as thoroughly as possible exactly what our materials accomplish—that is, the ways students, instructors, or the institution can benefit from their use. Whether the accomplishments are trivial or profound, this is really all that program evaluation is about.

These, then, are the primary factors to consider before revamping a curriculum. There are, of course, a litany of other problems that will inevitably appear during program development, but their resolution should be considerably less difficult and time-consuming if a formal conceptual framework for the project has been constructed around these five major issues.

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