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ABSTRACT

Data from a survey conducted with National Science Foundation support, which was published in December 1970, are reviewed. It is pointed out that, with regard to computers in higher education, national goals stated in the Rosser and Pierce Reports have not been attained. Inspection indicates that quality was lacking in hardware or courses in nearly half the associate and bachelor's degree programs in data processing and computer science offered in 1966-67. The conclusion is reached that more and more computers will be needed in higher education and pleas are made for continuing studies on the status and goals for computing in higher education, for the improvement of degree programs and for a national testing laboratory for educational technology. (Author)

Using Computers in Higher Education: Past Recommendations, Status, and Needs

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Data from a survey conducted with National Science Foundation support, which was published in December 1970, is reviewed, and it is pointed out that, with regard to computers in higher education, national goals stated in the Rosser and Pierce Reports have not been attained. Quality was lacking in hardware or courses in nearly half of the associate and bachelor's degree programs in data processing, computer science, etc., offered in 1966–67. A plea is made for continuing studies on status and goals for computing in higher education, improvement of degree programs, and a national testing laboratory for educational technology.

Key Words and Phrases: higher education, computers, degree programs, national goals, testing laboratory, educational technology

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[1] First year of Office of Computing Activities. The increase reflects some consolidation as well as new monies.

[2] Budget Requests, NSF news release 70-107, February 2, 1970.

[3] NSF budget proposal to Congress for fiscal year 1972.

Past Recommendations

There have been, in the United States, two major reports which have made recommendations on computers and computer funding in higher education. The first one, published in 1966, is entitled "Digital Computer Needs in Universities and Colleges" and is referred to as the Rosser Report after J. Barkley Rosser who was the chairman of the Committee on Uses of Computers of the National Research Council which conducted the study. This study was sponsored by the National Academy of Sciences and supported by the National Science Foundation. The other report was published a year later, in 1967, by the President's Science Advisory Committee of the Office of Science and Technology. It is entitled "Computers in Higher Education" and is referred to as the Pierce Report after John Pierce who was the chairman of the panel which prepared the report.

Each of these reports has had considerable impact on the funding of computers in higher education. Before their publication, computer funding was handled mostly by the Mathematical Sciences Section of the Physical Sciences and Engineering Division of NSF. However, in 1967, the National Science Foundation, probably because of the influence of these reports, established a separate "Office of Computing Activities" charged with the responsibility of computer funding. For the past few years, funding for computing activities through these offices has been as follows:

	in millions of dollars
1966–67	13
1967–68[1]	22
1968–69	17
1969–70	17
1970–71[2]	15
1971–72[3]	17.5

Studies of Status

Besides the two reports mentioned above, two extensive research studies have been conducted on computers in U.S. higher education—both sponsored by the Southern Regional Education Board with support from the National Science Foundation. The first study was a survey based upon a stratified statistical sampling of 669 of the then existing 2,219 institutions of higher education listed by the U.S. Office of Education. The results were published by the SREB in 1967 [1]. The second study consisted of an inventory of computers in higher education during 1966-67 and was taken from reports received from 1,965 of the 2,477 institutions. The National Science Foundation's Office of Computing Activities again supported the study, and the work was carried out by the Computer Sciences Project of the SREB. It was published by the NSF in December 1970 [2], and the president of each institution of higher education was given a copy. During 1971, the inventory will be updated with information from the 1969-70 period; publication is expected by January 1, 1972.

Recommendations vs. Status

Funds for computers in higher education have not kept pace with projected needs (see Table I). For example, in the Rosser Report the National Academy of Sciences projected that for fiscal year 1969 institutions would require $369 million for computing activities. Of this amount the institutions would supply 27 percent; the federal government, 60 percent; and other sources, 13 percent. The SREB sampling survey, which contained figures for 1964-65 with projections by the institutions for 1968-69 (FY 69), estimated that the institutions would need $317 million and that they would provide 45 percent of that amount; 35 percent was expected from the federal government and 20 percent from other sources.

Early 1969, at Congressional hearings for NSF appropriations, Dr. Milton Rose, as head of the National Science Foundation's Office of Computing Activities, estimated in his testimony that the actual expenditures would be $263 million and of this amount the institutions were providing 54 percent, the federal government only 23 percent, and other sources the remaining 23 percent. From these figures it would appear either that the goals we have set are unrealistic or that we need to do much more toward meeting the goals established by the Rosser and Pierce Reports.

Institutions With Computers

As of June 30, 1969 (see Table II), I estimate that half of the institutions of higher education had no computer facilities. The SREB 1964-65 survey, with a cutoff date of about June 30, 1965, estimated that 707 of the 2,219 institutions had computer facilities while the other 1,512 did not. In the 1966-67 inventory two years later, 981 had computer facilities of some sort, 1,496 still did not; but by this time there were 2,477 institutions. The number of institutions was increasing nearly as fast as the number of institutions that were acquiring their first computer, although this fact is not quite representative because the U.S. Office of Education went to a new classification scheme whereby several multicampus institutions were counted separately in 1966-67. My estimate as of June 30, 1969, indicates that 1,255 institutions had computer facilities, while 1,282 still did not. The Pierce Report recommended that *all* universities and colleges should have some kind of computer facilities; that none of them should be without.

Student Access to Computers

As of the end of FY 69 more than a million students in higher education still had no access to computer facilities (see Table III). In 1964-65, the 1,512 institutions without computers enrolled 2.4 million students. The total enrollment then in all institutions of higher education was about 6 million. In 1966-67, 1,496 institutions without computers enrolled 1.6 million students, and in 1968-69, the 1,282 institutions without computers enrolled about 1.2 million.

Costs per Student

What are reasonable costs per student for computer use in small colleges? The Pierce Report recommended an expenditure of $60 per student per year. For a college with 1,000 students, that is $60,000 a year. An experiment, which was sponsored by SREB and supported by NSF and which began in July 1968, was made with time-sharing and small computers in eight colleges. Each college, enrolling from 1,000 to 3,000 students, was shown to have costs for instructional use that averaged $20 per student per year (see Table IV). With the much smaller minicomputers now available, it may be possible to provide minimal computing experience for about $10 per student per year.

Operating Cost Ratios

Suggested cost ratios for various types of computer use in education are given in Table V. For instruction in computers, a ratio of $6 for hardware to $3 for personnel to $1 for other is suggested. Staff costs will be low since the students do the programming. If the computer is used primarily as a computational tool in research and instruction, the recommended ratio is 4.5 for hardware to 4.5 for personnel to 1 for other; and for administrative data processing the ratio is 3 to 6 to 1. Where the computer is more deeply involved with instruction (e.g.

Table I. Funds for Computers in Higher Education, FY69 (source NSF)

	Institutions	Federal	Other	
Projected by Rosser Report	27%	60%	13%	$369 million
Projected by Inst. (SREB)	45%	35%	20%	$317 million
Expenditures Estimated by NSF (Rose)	54%	23%	23%	$263 million

Table II. Computer Facilities in Institutions of Higher Education

	Number of Institutions		
	With computers	Without computers	Total
SREB/NSF 1964-65 survey June 30, 1965	707	1,512	2,219
SREB/NSF 1966-67 Inventory June 30, 1967	981	1,496	2,477
SREB Estimate June 30, 1969	1,255	1,282	2,537
Pierce Report Recommendation	All	None	

Table III. Numbers of Students Enrolled at Institutions With No Computer Facilities

	Number of Institutions	Number of Students (Millions)
1964-65	1,512	2.4
1966-67	1,496	1.6
1968-69	1,282	1.2
Pierce Report Recommendation	0	0

Table IV. Cost per Student for Computer Use in Small Colleges

Pierce Report Recommendations	$60/year
SREB/NSF Experiment (1st year) Time-sharing and small computers in eight colleges (1000 to 3000 students each)	$20/year
Minicomputer in Small Colleges (1000 students) (Approx. $20,000 purchase) Optical Card Reader/Teletype I/O	$10/year (est.)

Table V. Suggested Cost Ratios for the Various Types of Computer Uses in Education (includes development and maintenance of operating systems and compilers, i.e. B.U.)

Primary Use	Hardware	Personnel	Other
Instruction in Computers	6	3	1
Computational Tool in Research and Instruction	4.5	4.5	1
Admin. Data Processing	3	6	1
Instr. (CAI, CMI, CBI)	2	7	1

CAI, CMI, CBI) the ratio is about 2 to 7 to 1. These ratios include development and maintenance of operating systems and compilers, i.e. B.U. (before unbundling). Many of the manufacturers have "unbundled" the prices so that prices for some software are separated from the hardware prices.

Quality of Degree Programs

Based upon information reported by the colleges for the period 1966–67, it is my opinion that in 43 percent of the 144 reported associate degree programs quality is lacking in hardware or in course offerings. I judged that 99 programs had adequate hardware, 120 had adequate courses, and 82 associate degree programs had both adequate hardware and courses; 28 had marginal hardware, 20 had marginal course offerings, and 5 had both marginal hardware and courses; 17 had inadequate hardware, 4 had inadequate courses, and 3 had both inadequate hardware and courses (see Table VI). Of the 144 associate degree programs reported, 122 were called "data processing" and most of these were in the two-year institutions. It is hoped that the situation has improved since 1966–67, although I am not quite certain we can be optimistic about this. My judgments were based partly on a few personal observations. For instance, during 1966–67 an IBM 1401 was generally considered to be adequate hardware for a two-year program in data processing. Today, unless the hardware can handle COBOL, many educators feel that it is not adequate. An IBM 1620 without a printer was considered inadequate support for a degree program in data processing. On the other hand, if the associate degree program was in computer programming or computer technology the IBM 1620 without a printer was considered adequate.

Percentage-wise the situation is even worse at the bachelor's level in computer science. According to the recommendations of the Curriculum Committee on Computer Science (C^3S) of the Association for Computing Machinery [3], "Degree programs require regular access to at least a medium-sized computer system of sufficient complexity and configuration to require the use of an operating system." This statement is later translated into dollars: "The total operating costs of such systems are at least $20,000 per month." The work of the C^3S spanned nearly eight years (1960–68), with the latter years supported by a grant from the National Science Foundation.

Table VI. Quality of Hardware and Course Offerings for Associate Degree Programs

Quality Level	Number of Programs		
	Hardware	Courses	Both
Adequate	99	120	82
Marginal	28	20	5
Inadequate	17	4	3
Total	144	144	—

Even with a liberal interpretation of the C³S recommendations, I found that for bachelor's degree programs in computer science quality was lacking both in hardware and in course offerings. Adequate hardware existed for 18 programs and 18 had adequate course offerings based upon the ACM Committee recommendations (see Table VII). In 14 of the programs adequate hardware and course offerings existed, i.e. in 44 percent of the 32 bachelor's degree programs reported in 1966–67. Since the information upon which these estimates were based was collected nearly a year before C³S published its "Curriculum 68" report, the figures given in Table VII may be of historical interest only. The impact of the report and also the growth that has occurred in the interim may have raised the level of quality. Some of the doctoral programs are now turning out Ph.D.'s who are joining the faculties of these programs.

Needs

1. It is time for a new look at the need for computers in higher education. Present guidelines may be out of date due to advances in technology, changes in funding patterns, added years of experience, and a greater awareness about computers—their potential, their limitations, and their uses. As I mentioned above, something is wrong; either we have the wrong goals or we have not worked hard enough toward attaining those goals. Perhaps it is time for another national study which would produce a new set of goals. If so, who should conduct it? The National Academy of Sciences has created a Computer Science and Engineering Board. Perhaps this is the kind of group that might well undertake such a study.

2. An independent and unbiased testing and reporting agency for education technology is needed—an organization such as the Consumers Union of the U.S., Inc., either an extension of the Consumers Union or a new organization. The flood of new terminals and other peripherals coming on the market can only confuse the consumer, for example. Some products will perform well, others will not. Some may be quite satisfactory in an office or laboratory where use is occasional and where there are "friendly" operators, but they will not stand up in an educational setting where a machine is used steadily hour after hour by "unfriendly" operators.

Table VII. Quality of Hardware and Course Offerings for Bachelor's Degree Programs in Computer Science

	Number of Programs		
Quality Level	Hardware	Courses	Both
Adequate	18	18	14
Marginal	3	8	1
Inadequate	11	6	3
Total	32	32	—

In the use of audiovisual aids there have been a number of problems. In the appendix of *Run, Computer, Run* [4] there are several letters from correspondence between the author and Company XYZ about problems which were encountered with a projector-recorder combination manufactured by Company XYZ. The reasons the author did not disclose the model and manufacturer of the device are obvious. Yet such disclosures serve only to caution the buyer; they do not prevent him from encountering the same frustrations.

The Consumers Union purchases items on the open market and submits them to extensive tests. The results of the tests are then published in reports, complete with model names, manufacturers, and prices.

The scope of such an organization should include testing the durability and ease of use of hardware items, the efficiency and flexibility o. software packages, and hardware-software interactions. Conducting such investigations should not be dependent upon government grants or contracts. Private foundation grants would be helpful in starting this kind of activity but the customer should eventually carry the burden through subscriptions to the reports.

Summary

More and more computers will be required in higher education: universities will be needing more computers, larger computers, links to other computers, and nodes of computer networks; four-year colleges will need more computers and links to larger computers; and two-year colleges will need links to other computers and more of their own small computers.

We need continuing studies of the status of this multimillion dollar item in higher education. We need information which will help us to improve the degree programs, and we need an unbiased testing laboratory for education technology.

In order to assist higher education in obtaining the resources needed to provide adequate computer facilities for students and faculty, we must continue to reassess our national goals with regard to computer needs in U.S. higher education.

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