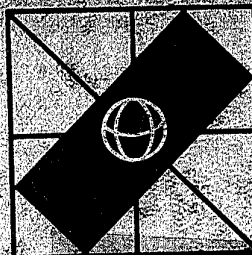


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A MULTILEVEL NATIONAL APPROACH TO COMPUTER EDUCATION*

Carlos J. Lucena †
Departamento de Informatica
Pontificia Universidade Catolica
Rio de Janeiro, Brasil

This paper describes the general characteristics of an integrated computer education program under implementation in Brazil. Some of the key strategies used to support and develop this program are presented and discussed.

1. INTRODUCTION

Computer technology has become an integral part of the economy of some developing countries. It is extremely important to those countries not to be only a marketplace for this new technology in which it is used for just a sparse set of applications (sometimes with questionable results). There are strong indications that computer technology can constitute a powerful tool to foster the social and economic development of the country. For that to be achieved, a lot more is required in terms of computer education (education about computers and their uses) than the superficial instruction which can be bought from the computer manufacturer together with the equipment. In fact, a broad and comprehensive educational program is required as an integral part of the country's educational system. Some examples of what can be achieved through adequate computer education in a developing country can be found in Lucena (1974).

Being familiar with both the Brazilian approach to computer education and several similar programs that exist in different countries, the authors believe that the Brazilian model has a number of interesting aspects which are worth being reported.

In this paper we describe the Brazilian national approach to computer education and highlight its major accomplishments. Although the size and complexity of the Brazilian problems in this area may look far too small to some, the point we want to make is that a systematic approach to these problems at an early stage will assure a balanced development of the area. Besides, this can be achieved with a very positive influence in the development of the country. In the following sections we first provide some background about the area of Computer Education in Brazil. In sequel we discuss the multi-level educational program which is being implemented in the country. This program attempts to relate to most of the sectors of the country's educational system. We proceed by describing and commenting on government actions that have been supporting this program.

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†with Luiz C. Martins, Coordenacao das Atividades de Processamento Eletronico (CAPRE), Brazil

This paper does not represent an official position of the Brazilian government. The authors describe their points of view about some programs with which they had involvement as government consultants.

We do not expect the approaches described in this paper to be regarded as universal solutions to the problems of planning computer education at a national level. We do expect to attract the interest of representatives of other countries and to lay down some ground material that can be the basis for useful international cooperation.

2. BACKGROUND

The teaching of electronic computing and related concepts in elementary and secondary schools in Brazil is only a very exploratory activity. Only a few private institutions have begun to offer some instruction in computing. These efforts are early initiatives towards adhering to a new governmental requirement that calls for the adoption of more professionally-oriented curricula in elementary and secondary schools.

Universities, as it should be expected, had a pioneering role in fostering computer education in the country. Altogether, there are in the country fifty institutions of higher education (universities, technological institutes, etc.) that have computing facilities and offer some kind of computer-related programs. There are at the present eight graduate programs in computing related areas (computer science, systems engineering, etc.). Besides turning out academic personnel to other universities, these programs have been very active in producing well-trained professionals to several institutions in the country which are involved in some state-of-the-art computer applications. Only five universities (four of which differ from the previously mentioned ones) offer a full-fledged undergraduate curriculum in computer science (as opposed to the more typical situation which is to have computing disciplines offered within classical areas in technology and social sciences). A recent outgrowth of the universities' activities has been the establishment of the so-called Colleges of Computer Technology, affiliated to the university system. A College of Computer Technology offers a two-year program (equivalent to half a Bachelor's Degree program) which is meant to produce intermediate level technicians to industry. There are six of these colleges established within universities and six

others are in the process of creation.

Outside the regular educational programs, computer education is also provided by private enterprises and computer manufacturers. There are 26 firms that offer training programs in computing from basic courses in computer operations and programming to advanced seminars for computer specialists and executives. We did not include in this last total the universities' extension programs aimed at the same market. Only ten major enterprises have their own complete training programs, some of them nation-wide. (The Federal Computing Bureau (SERPRO) has training staff and facilities in nine states of the country). Altogether, the computer manufacturers that operate in Brazil maintain thirteen training centers in the country.

The Colleges of Computer Technology and the private training programs attempt to supply adequate manpower to a market with the following characteristics. The following table displays the number of computer operators, programmers and senior programmers (software systems designers) in the years 1973/74 as well as estimates for 1975.

	1973	1974	1975
Operators	1800	2650	3650
Programmers	2150	3250	4650
Sr. Programmers	1700	2500	3500

In the short term, the available mechanisms and institutions that educate computer specialists for industry seem to be able to satisfy quantitatively the market's requirements. A major concern has to do with the adequacy of the training programs to face the increasing requirements of quality being imposed on industry. Outside of that, the major question remains of achieving a significant impact on the country's technology and administrative structure through using computing as a tool for the enhancement of technology applications.

3. COMPUTER EDUCATION PROGRAMS

In this section we describe schematically the multilevel national program in computer education which is at the present being implemented through a number of government actions. We will not give here the motivation and rationale for the variety of forms of instruction to be presented as we expect this issue to be addressed by several companion papers in this Proceedings. Instead, we will emphasize the structure of the educational model which is being adopted in Brazil.

In order to effectively impact the country's technological and administrative infrastructure, an integrated system was put together which tries to capture most of the relevant educational aspects related to computing. In the Table A2 of the Appendix such a system is displayed. The terminal careers (non-rectangular boxes) which are marked by an asterisk are still non-existent in the country.

In order to determine priorities in government support to the several forms of educational programs, as well as to investigate the way of achieving adequate levels of education by area of activity a number of investigations took place. Table A1 in the Appendix summarizes the current point of view of Brazilian planners about the participation of each form of educational program in various professions. In Table A1, X's indicate the required educational program per area of activity.

Our focus from now on will be on how government programs can support the Education Programs.

4. STRATEGIES FOR THE IMPLEMENTATION OF COMPUTER EDUCATION PROGRAMS

A number of initiatives from both the government and private groups established the foundations and presently support the development of the program outlined. The federal government has been actively involved with the computer education area. Specifically, the Secretary of Planning's Coordination of Data Processing Activities (CAPRE), through its education division has been active in promoting undergraduate and general education, while the Brazilian National Research Council (CNPq), through various programs has been supporting graduate education. From the private initiative standpoint, the SUCESU association (major Brazilian computer user's society) and the Brazilian Council of University Rectors have had a distinguished role in the development of computer education in the country.

The general goals of CAPRE are to propose ways the federal government can optimize its investments in data processing and to propose forms through which an adequate productivity can be achieved in the new and existing government computer installations (that includes computer installations financed by government funds). An issue that naturally falls within the mentioned scope is the achievement of an adequate level for computer specialists. That, in turn, has motivated a joint work between CAPRE and the Ministry of Education in the following directions:

- a. Planning of computer education,
- b. Creation and funding of Colleges of Computer Technology,
- c. Inter-regional cooperation,
- d. Promotion of seminars,
- e. Teachers' training programs.

CAPRE has been active in evaluating the country's computer personnel needs both in quantitative and qualitative terms. The program outlined in the Appendix reflects to a great extent a profile of the activities of the computer professional in Brazil, that was delineated by CAPRE's specialists assisted by knowledgeable industry representatives (this activity is, in fact, an outgrowth of a pioneer effort by SUCESU).

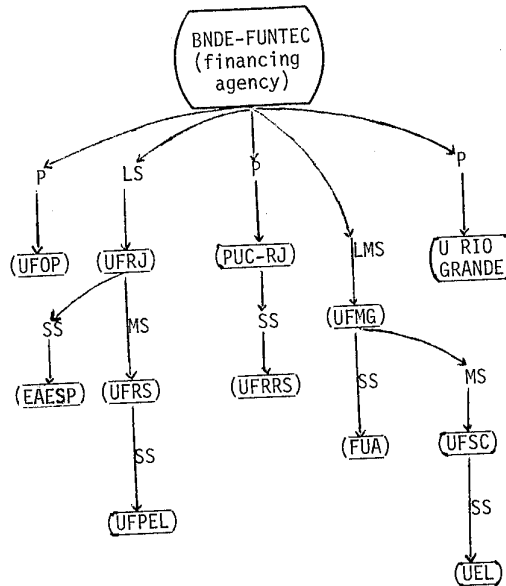
A major effort undertaken in the last couple of years was the creation and subsequent support and supervision of the program of Colleges of Compu-

ter Technology. As mentioned before, this program is undergoing an extensive expansion operation. There is no question that the market will eagerly absorb the technicians produced by this program. What is now left to be done is to evaluate the impact that this level of professionals will produce in industry and government and to feed back into the program the experience of the market with this type of professionals.

A very interesting aspect of CAPRE's activity that has provided better means for the development of computer education is its inter-regional cooperation program. Very often university computer facilities in Brazil are financed by the federal government. For that reason, CAPRE, together with the universities where those facilities are located have worked out a strategy through which smaller universities and even private enterprises in the business of offering computer training can have easy access at a very low cost to the eventual idle time in larger universities' computer installations. The needs of some universities for more computing power and the bid by others for entering the computer field has led to some interesting redistributions of computing power within regions of the country. The figure below illustrates one such redistribution that took place in early 1974. The labels that appear in the figure are left uninterpreted and stand for the names of Brazilian universities located at different regions of the country and which are at different levels of development. This kind of optimization attitude has led to an intense investigation of the issues of regional centers and networking, and as early as late 1975 some solutions along these lines will be in operation.

In the area of promotion of seminars and teacher's training programs, CAPRE has co-sponsored and co-organized a considerable number of events aiming at upgrading the computer professionals from industry and government and preparing teachers for the introduction of computing technology in the curricula of the schools. An interesting modality of seminars is the so-called "seminar on the use of computers in universities." Five of these seminars have taken place since 1971. The whole community of specialists in computing from Brazilian universities (both computer science departments and computing centers) get together for one week to discuss (in a workshop mood) the role of computer education in the academic environment and how it should be approached. Academicians then have the opportunity of having their programs evaluated by their peers. This kind of discussion seems to have brought an interesting consensus within the academic community about quality of computer education and ways of achieving it.

At this point we will comment on some other government actions that have helped support the development of graduate programs in computer science. These programs contribute to the transference of new technologies to industry and to



Symbols: P - peripherals
 LS - large scale system
 LMS - large medium scale system
 MS - medium scale system
 SS - small system

the training of teachers. We will talk about the integrated action of the Brazilian National Research Council (CNPq) together with other agencies in the Ministry of Planning in the selected financing of research in computer science and computer applications. This program, which started in 1965, is presently entering (from our point of view) its third phase. In the first phase (approximately 1965-1971) little attention was paid to the object of the research as it was necessary mainly as a training tool used as part of the structure of the graduate programs (most leading to Master's Degrees).

During this phase there was a massive effort to educate junior faculty members for universities which were entering the computer field. A percentage of the students did go into industry where they became useful more because of their ability in problem solving in general than because of their specific knowledge in computing (they were generally much better in theory than in practice). A second phase followed in which industry and government, being eager for a quick transference of technology, were very interested in financing development-type projects of very short-range applicability. This phase, which is not finished yet, is characterized by an intense migration of academic people to industry and government.

The equilibrium point is being reached because both industry and government are beginning to be

able to handle even some sophisticated development projects for which the need of the university was felt in the past. The university is entering a stage in which its faculty has strictly academic interests but enough motivation to interact with the "real world." This is the phase we hope to be entering. In fact, the attitude of the sponsors and the motivation of the academic community seems to indicate that. A new and challenging problem has to be faced now: the definition of a class of problems which are "mission oriented" without being either pure development or remote issues for developing countries. One advantage of the computer technology field is that, as in any new field of research, there are still a number of challenging problems that are both academically attractive and yet of relatively short term interest for industry and government. The problem of networking of computers, as previously mentioned, seems to fall into this category.

Another class of programs supported by the CNPq (and CAPRE) are the programs of international cooperation. Programs currently exist between Brazil and France, United States, Canada, and Germany. These programs have been giving a diversified experience to the Brazilian community of computer specialists, from the technical level to the post-graduate education level. One of the older programs, for instance, established a twinning relationship between two universities in Brazil (PUC-RJ, and University of Sao Paulo) and the University of California at Los Angeles. For

over two years members of the faculty of these universities have been exchanging experiences in the areas of computer architecture and software engineering. The number of results produced up to the present is stimulating the sponsors to extend the program to include other institutions and research areas.

5. CONCLUSIONS

We have tried in this paper to make the point that the planning of computer education on a national scale requires a complex multi-level program in order for a developing country to be able to take full advantage of the multiple uses of computer technology. The diversified actions required to support such a program have been illustrated through some measures that have been actually used in the case of Brazil.

6. REFERENCES

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APPENDIX

Table A1

SUPPLIERS OF COMPUTER EDUCATION

Demand for Computer Education	Secondary: Professional Option	Colleges of Computer Technology	Universities	Private Training Institutes	Training within Institution	Manufacturer	TV, Radio, Journals and Other Means
<u>Sensibilization</u>							
Public in general	X			X	X	X	X
Employees of a firm in the process of using computerized facilities				X	X	X	X
Executives in general				X	X	X	X
<u>Computing as a means</u>							
Higher education careers			X	X	X	X	X

Table A1, continued from previous page

Demand for Computer Education	SUPPLIERS OF COMPUTER EDUCATION						
	Secondary: Professional Option	Colleges of Computer Technology	Universities	Private Training Institutes	Training within Institution	Manufacturer	TV, Radio, Journals and Other Means
Management in general			X	X	X		X
Management of technology			X	X			X
Computing as an end							
Keypunching and coding	X			X	X	X	
Data preparation	X			X	X		X
Operators	X	X		X	X	X	X
Systems programmers		X		X	X	X	X
Applications programmers	X	X		X	X	X	X
Technical representatives		X	X	X	X	X	X
Maintenance and manufacturing		X				X	
Computer systems design		X	X	X			X
Teachers			X	X			X
Professors and researchers			X				X

Table A2

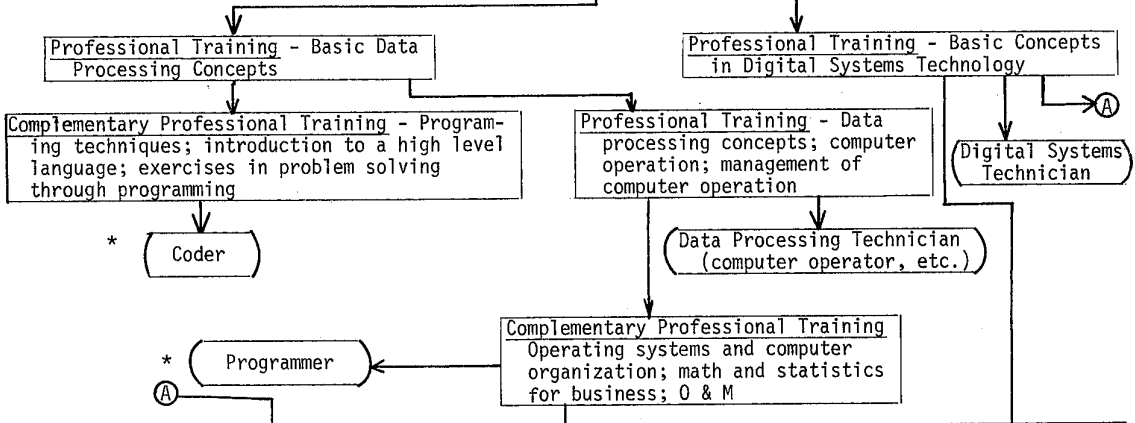
Elementary School

General education - Introduction to the algorithmic approach
 Professionally-Oriented Knowledge - Value of information; how information is gathered, treated and distributed.

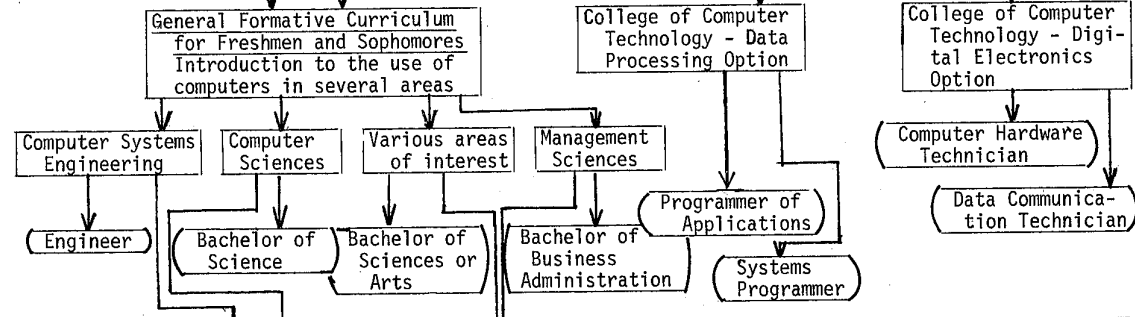
Professionally-Oriented Knowledge - Introduction to informatics; the role of computers in a modern society; simple computer applications; professions in informatics.

Secondary School

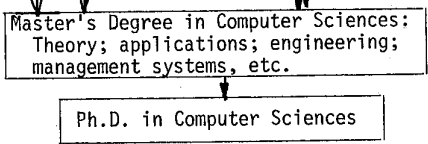
General Education - Organization of information: the concept of information system; examples of simple computer applications; professions in informatics



Undergraduate Programs



Graduate Programs



*Special computer applications curriculum