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ABSTRACT

Part A contains general comments on various aspects of computer science education, particularly that for the mass. Part B describes some of the concrete examples carried out successfully. (Author)

# COMPUTER SCIENCE EDUCATION

by Sigeiti MORIGUTI

## INTRODUCTION

Part A contains general comments on various aspects of computer science education, particularly that for the mass. Part B describes some of the concrete examples carried out successfully.

## A. GENERAL COMMENTS

A1. Programming. Study on computers must start with programming. It is only through programming that one gets good insight in the field of computer science and computer applications.

Computer programming education without actual practices can hardly be useful. Therefore there should be a good computational facility and an adequate amount of machine time available to the students.

Programming is no longer a special skill owned by a small group of professional people. Like driving, it is a skill required of millions of people.

Education aimed at producing a huge army of professional "programmers" as such is not recommendable. Instead, we should give programming skills to managers, business people, engineers, scientists, etc. — practically all people who can contribute to the use of computers.

A2. Computer Science Education in Universities. On the graduate level, specialised courses (departments) in computer science are desirable. However, in the countries (e. g. Japan) where usual practice is to put a graduate course upon a corresponding undergraduate department, a great care must be taken so that a particular discipline will not monopolize the graduate course, thus alienating other closely related disciplines. It is much recommendable to have a graduate course organised upon several undergraduate disciplines, with an inter-departmental committee taking care of the course.

On the undergeaduate level, it is not sure whether establishment of a specialised department of computer science is recommendable or not. Arguments against it are as follows:

Firstly, computer science and information processing have many different aspects and they are being handled in many well-established departments —— electricity and electronics, mechanical engineering, mathematics, applied mathematics, mathematical engineering, etc. Establishment of a new department may deprive the most attractive activities of those departments. Also the new department may have a long time of struggle before it becomes a really unified department.

Secondly, computer science is still too young to be a discipline on the undergraduate level. Undergraduate education without a backbone of disciplining can easily deteriorate into a crum of fragmental knowledge and information with very short length of life.

Thirdly, universities capamble of establishing such a new department are already too big and threatened by the student riots. No more expansion is desirable there.

Forthly, small universities may jump to this opportunity of expansion. But they often lack the prestige to attract competent faculty members and good students. A department with a nice name and poor reality will cause a great problem in the future.

Computer science as general education is very important and must be given to almost all students in all fields, much like language education.

There are two conditions about when to start this kind of education:—— (1) The earlier, the better. It does not require much previous knowledge and hence can be treated on freshman or sophomore levels. (2) It is important that one can utilise the skill profitably soon after he aquires it. In this sense, to incorporate it into a course on differential equations or statistics will be a good idea. Combination of computer programming with numerical analysis into a course is another approach.

Any, way, it is very essential to provide the students with surficient facilities for practice —— computer itself, input machines, and programming advisors.

Use of computers in other courses must be encouraged. In Science and Engineering, there is no problem here. The faculty members there are already very anxious. (Only thing necessary is again providing the good facilities.) In other branches, special care must be taken to promote this.

A3. Educational Engineering. It is very important to improve the efficiency of higher education, and it can be achieved through extensive use of computers. Audio-visual methods, programmed learning, computer-assisted instruction, and simulation are some of the promising approaches. Bold and large-scale experiments are due.

Those experiments can best be addressed to the computer science education itself, though they should not be confined there. Experimental universities are worth considering along these lines.

A4. Computer Education in Lower Schools. Junior Colleges are functioning at present as major sources of junior programmers, especially girls. However they must be well trained in order to be useful. Also general education should not be neglected.

Technical and commercial high schools must be well equipped with computers so that their products will be adequately prepared for the works in computerized environment. Workshop training should be provided for those who intend to be specialists in computers.

## B. CONCRETE EXAMPLES

B1. Introduction to Computer Programming and Numerical Methods. The Faculty of Engineering of a university gives a course of the above title to sophomore students. The classes meet one hour and a half every week for 12 weeks.

This year, it is being given to 600 out of 900 students. Next year, it is hoped to be given to all Engineering students.

The contents are:

1. Operations on real numbers (with input and output).
2. Minimum value (decision and jump).
3. Sum of products (array and DO-loop).
4. Solution of algebraic equations.

5. Taylor series.

6. Linear equations.

7. Least-square approximation.

8. Ordinary differential equations --- Euler method.

9. Subroutines without arguments.

10. Subroutines with arguments.

11. Functions. Simpson's rule.

12. Eigenvalues of a matrix--- Jacobi method.

Three programming exercises with actual runs are required.

B2. Group Training Course in Computer Applications. The Government of Japan is going to give the second course of the above title as part of its Technical Cooperation Schemes for developing countries with the support of the International Computation Centre.

The duration is for two months. 16 participants will be accepted.

The curriculum consists of five categories as follows:

(1) Lectures and exercises on the fundamentals of programming. (a) Fundamentals of FORTRAN, arithmetic operations, control statements, arrays, functions and subroutines. (b) Mean and variance, curve fitting, inversion of matrix, characteristic roots and Monte Carlo methods. (c) Logical concepts of item, record and file, flow chart, input/output media and operating system. (d) Efficient operation of computers, system monitor, job monitor and time-sharing system.

(2) Lectures and demonstrations of various computer applications. --- Statistical works, national economic planning, information retrieval, trading statistics, information on labor market, taxing calculation, fare calculation in a telephone company, planning in the electric power industry, applications in broadcasting, applications in construction, inventory control and production control, aerial survey, applications in fisheries, statistical analyses in agriculture.

(3) Lectures or group discussions on various topics. --- History of computers, on-line real-time system, pattern recognition, graphic display, analog elements

and hybrid system, simulation, processing of verbal information, computer applications in education, procedures of introduction of computers, administration of computer centers, future trends of computers.

(4) Term project. --- analysis, programming and operation about the problem selected by the participant.

(5) Guided tours. --- Bureau of Statistics, The University of Tokyo, Seat Reservation Center of the Japanese National Railways, NHK(Japan Broadcasting Comrporation), Japan Meteorological Agency, A steel and iron plant, a department store, University of Kyoto, University of Osaka.

Many tutors will help the participants in exercises and term projects.

B3. NHK Computer Course. NHK(Japan Broadcasting Corporation) put a computer course through its educational TV channel, from April to October 1969, one hour every Sunday, with re-broadcasting on the following Saturday.

Almost a million copies of the textbook have been sold. The film records are also available. The entire set of 26 shows will be put on the air again twice a week from October 1969 to April 1970.

The contents are:

(1) Arithmetic operations. --- Difference of two integers, profit, input/output devices, summary.

(2) Decision and jump. --- Income and payment, mail fare, stature of pupils, selecting a dog.

(3) Array and repeated operations. --- Annual income, tax rates, end-of-the-year adjustments, tax for the bonus.

Computer architecture.

(4) File-processing. --- Internal sorting, merging, sorting of massive data, report-writing.

(5) Operations on real numbers. --- Representation of real numbers, bonus, computer time, quadratic equation, square root.

(6) Simulation. --- Model-building, flow diagram, program and results.

How to study from now on.