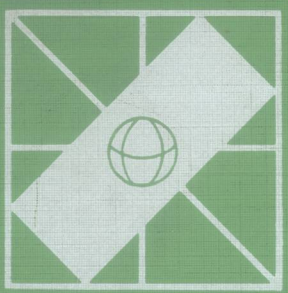
informatics education for all students at university level

edited by
f.b.lovis and e.d.tagg



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INFORMATICS EDUCATION FOR ALL STUDENTS AT UNIVERSITY LEVEL

Proceedings of the IFIP WG 3.2 Working Conference on Informatics Education for all Students at University Level
Delft, The Netherlands, 27 June - 1 July, 1983

edited by

F. B. LOVIS
Faculty of Mathematics
The Open University
Walton Hall, Milton Keynes, U.K.

and

E. D. TAGG
Formerly Senior Lecturer in Mathematics
University of Lancaster, U.K.

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Delft, The Netherlands, 27 June - 1 July, 1983

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EDITORS' PREFACE

The first Working Conference to be organised by IFIP WG 3.2, following its resurrection, was held at the Technische Hogeschool of Delft, Holland, in summer weather and a fine bonhomie.

31 Participants from 12 countries assembled to report on the work in their own universities, to discuss the present state of the art, to exchange ideas and to argue whenever appropriate about the immediate future of this field.

All attendees came by personal invitation from the Programme Committee and were selected as having achieved significant eminence in their work.

The papers in this book are arranged in order of presentation and are followed, in many instances, by a summary of the ensuing discussion.

The conference was excellently organised by the local committee, under the chairmanship of Professor Ir. D.H. Wolbers, of the host institution.

As editors of these proceedings we should like to express our thanks to all the authors, who did their best to lighten our load, to the Technische Hogeschool Delft, who provided us with all the facilities which we required, and, above all, to the two invaluable secretaries who worked extremely hard, with supreme efficiency and willingness: Mirjam Koetsier and Joke Pesch.

Frank Lovis
Donovan Tagg

FOREWORD

The conference on "Informatics Education for all Students at the University" was run under the auspices of the Working Group on Advanced Curriculum Projects in Information Processing (WG 3.2). This working group is under the general direction of the International Federation of Information Processing (IFIP) Technical Committee on Education (TC 3).

As suggested by the title of the conference, the aim was to look at the education and training of all university students in the use and application of computers in their own area of expertise. Separate departments of computer science have developed very rapidly, as well as programs related to computers in electrical engineering and electronics and also in some business areas. Now, however, with the advent of relatively inexpensive microcomputers and the greatly reduced cost of even larger computer systems, the role of the use of computers is expanding very rapidly. Almost all companies, departments, or groups can afford some type of computer and most, in fact, use it to their advantage. This raises the very important question of just how do we educate all of our college or university students to go out and meet this new world. It is a significant educational problem which we must face across all disciplines in the university.

Speakers from several subject areas were asked to comment on a number of questions related to the use of computers and computer science in the education of their students. Examples of the questions were:
How should teaching be changed, if at all, due to the advent of widespread use of computers? How will the pedagogic strategies of teaching change? How will the use of data bases be used as an integral part of the curriculum? How do you manage to continue teaching the fundamentals of the subject matter along with new computer techniques?

From the papers and discussions some common ideas, conclusions and problems emerge.

a. Just what to teach and how to teach the fundamentals of Informatics in the various disciplines needs further thought.
b. Teachers do not wish to sacrifice the fundamentals of their subject in order to teach informatics.

c. Most disciplines see the value of using computers, but there are still some teachers who do not.
d. Different courses are needed for different areas. There are not enough teachers of Informatics to teach all these courses, even if this were thought desirable. Most such teaching will need to be done by the faculties or departments concerned.
e. Most disciplines will need to use some basic Informatics material but even greater emphasis will have to be put on the use of the tools provided by Informatics.
f. There is not only a current problem of the use of computers in education, but also a continuing problem for the future as computers and computer science change. The solutions to these may clash at times.
g. Any future working group's efforts should involve both Informatics specialists and subject matter specialists.
h. The conference did not arrive at a consensus on the basic question posed in its title - how to teach informatics to "all students" or "across the curriculum".
i. Informatics education needs to be construed in a broad context of teaching effective problem-solving, including such issues as arriving at creative solutions and deciding when not to use computers.

W.F. Atchison,
(Chairman of Programme Committee)

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COMPUTERS IN EDUCATION - THE NEXT STEP

by J. HEBENSTREIT

Head of Computer Science Department
Ecole Supérieure d'Electricité
Plateau du Moulon - 91190 Gif/Yvette
FRANCE

The way computers are used in education has changed over the years in parallel to the way the use of computers has changed in society at large. This is perfectly normal because institutional education is a part of society.

Therefore, the most efficient method to try to understand how computers are going to be used in education in the next few years is to start from an analysis of how computers are used today in society at large.

INTRODUCTION

CAI is often discussed as a stand-alone discipline and is discussed solely in terms of pedagogical efficiency. It is true that the main issue of CAI is the best way of using computers in education but a much better insight is gained by replacing CAI in its social, technical and economic context where it can be shown that the way computers have been and are used in education is strongly parallel to the way they are used in society at large. Moreover, it is suggested that this approach opens new roads of investigation for the future use of computers in education.

1. - The first step in CAI

When the first computers appeared, they were very expensive, not to say too expensive, for any customer except the military.

A few years elapsed before IBM succeeded in the marriage between its punched-card equipment and the computer. These computers were generally small compared to those sold to the military but their prices, still high, did drop to a level where they became "affordable" for big companies.

What did "affordable" mean?

It meant that the renting of the computer was more than balanced by the salaries of the people who were replaced by the computer.

This point is important because it is the fundamental philosophy of the use of computers in the early sixties : replacing people by computers.

This same philosophy can be found in the early stages of CAI and explains, by the way, the success, in CAI circles, of Skinner's theory of learning [1].

According to Skinner, education is nothing but the transmission of knowledge and can be achieved by breaking down any subject into a well organized succession of items and a question and answer process.

A computer, being able to print items, to ask questions and to grade answers, can therefore replace the teacher, with the advantage of never losing its temper and of allowing each student to progress at his own pace.

A number of papers were published during this period trying to demonstrate by comparing the results of different groups of students that the computer was even more efficient than the teacher.

Even the improvements introduced by Crowder [2] have not changed the fundamental philosophy : to reduce teaching to a fully automated procedure implemented on a computer, i.e. to replace people by computers.

This is not to say that Skinner-Crowder techniques are not useful. They are useful, even today, for parts of teaching in the limited context of those areas which are of the check-list type (radio and television maintenance, rote learning, administration procedures, etc).

The interesting point is that they were presented as universal methods and were evidently along the line of the way computers were used in commerce and industry.

2. - The second step in CAI

In the early sixties, some very small scale experiments were made with courses in binary arithmetic, statistics, typing and German, on machines such as the IBM650, IBM1400 and IBM7000 series.

However, in industry and commerce, new needs were emerging, much more sophisticated than could be achieved with batch-processing.

Airflight reservation systems, online data entry, etc, required direct access and computing power for many users at the same time.

The technical answer was "time-sharing" which allowed expensive resources (CPU time, printers, tapes and disks) to be shared between many users. At this time, also, scaled-down computers (the term "minicomputer" was not yet coined) started to appear on the market.

In 1966, a special purpose CAI system became commercially available. This system, known as the IBM1500, incorporated specially designed terminals with a keyboard, a cathode ray tube and a light-pen, and was programmed using the author-language COURSEWRITER II. Using an 1130 or 1800 computer, it has a capacity of about 32 terminals. A special random-access film strip projector with up to 1000 pictures and an audio-tape unit with adapter were available.

The 1500 system was not a great commercial success because its price was well above what any significant number of potential users could afford.

After a few years and the sale of a few dozen systems, the production of the 1500 system was stopped. It remains, even today, the only example of a commercially sophisticated multi-media CAI system.

About at the same time and at the other extreme, started what is today the well-known PLATO system [3]. The initial theory was that a big computer with thousands of terminals would be cost-competitive with institutional teaching.

During this period, new ways of using the computer in education emerged, which started to make sense because of the decreasing cost of processing power : drill and practice, dialog mode and, because graphics started to be available, modeling and simulation.

However an even greater number of papers appeared than in the preceding phase, trying to show how computers could replace teachers.

But, finally, very little was taking place except some limited and local experiments.

3. - The next step in CAI

The first step in CAI was, by and large, an attempt to have the computer "mimic" the teacher (we would say today to simulate the teacher) with more or less success. This is no surprise because it is a constant trend in the history of technology that any new tool has its first form of use shaped by the past : the first cars looked like coaches, the first planes looked like birds, etc. It is only after a certain time that a new tool takes its final shape and its new potentialities are recognized.

During the second step, for instance, techniques like drill and practice and simulation started to be used. This was already an advance because, in these cases, one took advantage of the specific facility of computers : interaction.

Moreover, these uses of the computer could not be replaced by anything else; they are just impossible without the use of computers.

The next step in the use of computers started in the mid-seventies with the advent of the microprocessor which allows microcomputers to be sold today with a starting price as low as 100 dollars (not including the home TV to be used as a screen).

The impact of the existence of very low cost processing power is just starting to manifest itself in society at large.

The main phenomenon is a drastic change in how computers are used.

Whereas the cost of computers until now restricted their use to cases where they could replace people (something analogous to what happened at the beginning of the industrial era), it now becomes possible to use computers to assist people in their work.

Analysts in industry, commerce and administration are studying the daily activities of everybody working there, from the clerk to the top managers, to find out which part of their work requires human thinking (evaluation, imagination, decision-making, etc) and which part is routine work and can, therefore, be implemented on a computer.

More and more computers are used in Computer-Aided Activities (also known under the acronym CAX) like Computer Aided Design, Computer Aided Drafting, Computer Aided Manufacturing, Computer Aided Medical Diagnosis, Computer Aided Office Work, Computer Aided Documentation, etc.

This invasion of the professional life by the ubiquitous microcomputer, which will appear sooner or later on each desk and each work-station, is just beginning and will, without any doubt, continue and extend, even to private homes, as soon as useful services are available at reasonable prices (hotel and ticket reservation, electronic mail and telecopy, access to a variety of data-bases, etc).

4. - Impact on the teaching/learning process

As already stated, a parallel with what is happening in society at large is a good basis to try to find out how computers are going to be used in education, provided that the basis is the right one, i.e. what are the most recent trends are not what happened 10 years ago.