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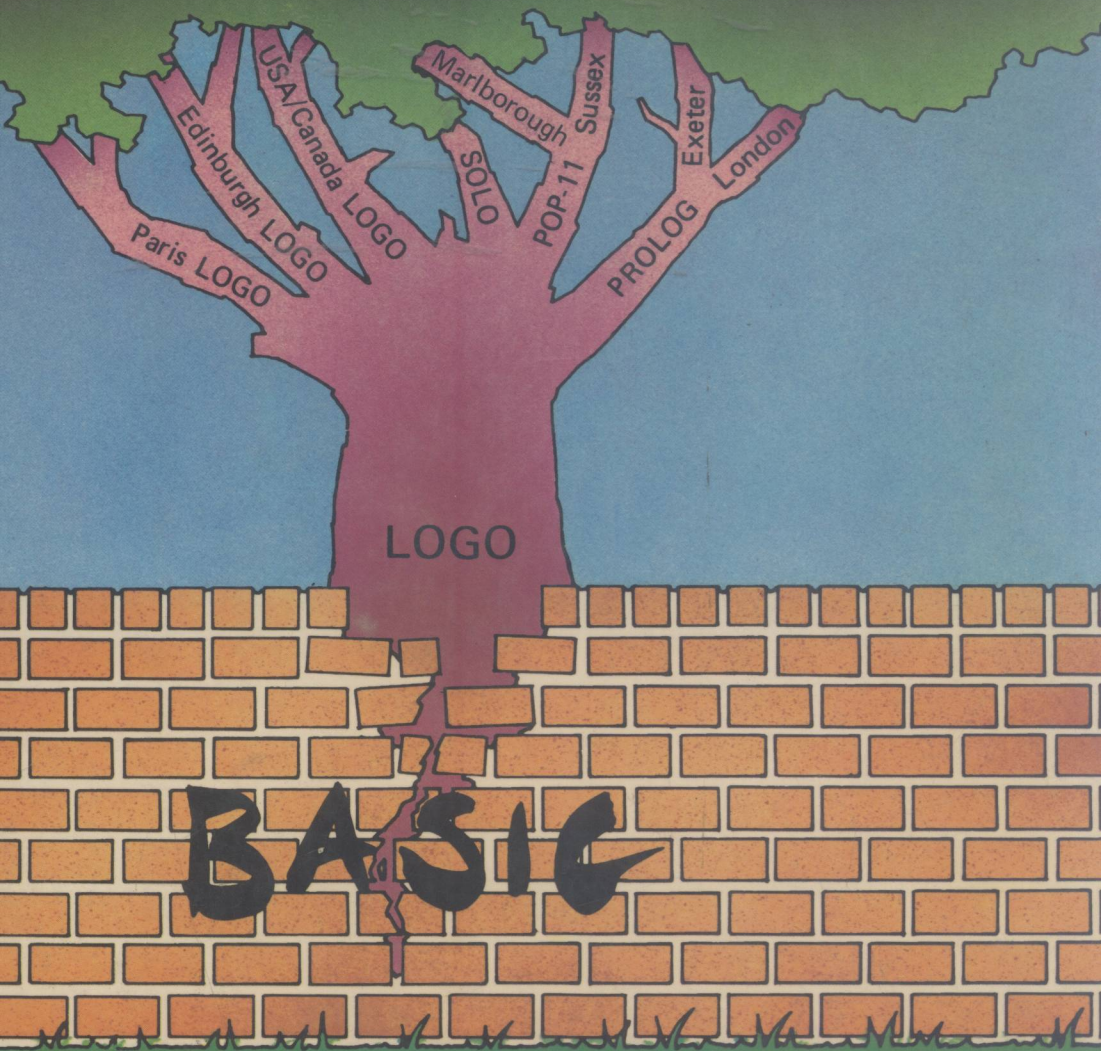
NEW HORIZONS IN EDUCATIONAL COMPUTING

Masoud Yazdani



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Editor:

MASOUD YAZDANI
Lecturer in Computer Science
University of Exeter
Exeter, UK

ELLIS HORWOOD LIMITED
Publishers · Chichester

Halsted Press: a division of
JOHN WILEY & SONS
New York · Brisbane · Chichester · Toronto

First published in 1984 by
ELLIS HORWOOD LIMITED
Market Cross House, Cooper Street, Chichester,
West Sussex PO19 1EB, England

Distributors:
Australia, New Zealand, South-east Asia:
Jacaranda-Wiley Ltd., Jacaranda Press
JOHN WILEY & SONS INC.
GPO Box 859, Brisbane, Queensland 4001, Australia

Canada:
JOHN WILEY & SONS CANADA LIMITED
22 Worcester Road, Rexdale, Ontario, Canada

Europe, Africa:
JOHN WILEY & SONS LIMITED
Baffins Lane, Chichester, West Sussex, England

North and South America and the rest of the world:
JOHN WILEY & SONS INC.
605 Third Avenue, New York, NY 10158, USA

British Library Cataloguing in Publication Data
New horizons in educational computing. –
(Ellis Horwood series in artificial intelligence)
1. Education – Data processing
I. Yazdani, Masoud
370'.28'54 LB1028.43

Library of Congress Card No. 83-22768

ISBN 0-85312-643-7 (Ellis Horwood Limited)
ISBN 0-470-20022-7 (Halsted Press)

Typeset by Ellis Horwood Limited.
Printed in Great Britain by R.J. Acford, Chichester.

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Preface

This book is a collection of interrelated papers each reporting on the experience of a group of researchers in making better use of computers in education, moving away from BASIC towards more powerful programming languages and environments, and benefitting from the fruits of the new discipline of Artificial Intelligence.

The book seemed to me to fall naturally into three sections on Logo, Prolog and POP. The order of chapters in each section is what seemed to me to be the most fruitful for a reader working right through the book. The papers, however, have been kept as self-contained as possible (at the risk of some repetition) so that they can be used individually for reference to a particular topic by researchers in Artificial Intelligence, Cognitive Science and Education.

A number of the papers are expanded versions of talks presented at the AISB Easter conference on Artificial Intelligence and Education held at Exeter University on 16–17 April 1983. The rest have either been written especially for this collection or are reprinted by the authors' permission in order to give a fair impression of the overall contribution of Artificial Intelligence to educational computing.

The introduction, 'Artificial Intelligence and Education', intends to set the scene as well as to establish the editor's personal views. This short note, and the time spent on compiling this book, was made possible by a study leave granted to me by Exeter University. The idea of this book arose when I was a research student, and a teaching assistant, at Sussex University. My gratitude to both institutions is acknowledged here. I would also like to thank Jackie Dean and Eric Barber for their help in proof-reading the book.

Dedicated to the memory of
the late Professor Max Clowes

Acknowledgements

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Introduction: Artificial Intelligence and education

One of the major areas of human endeavour is education. The result of some form of the interaction between adults and children in places known as 'schools' is labelled 'learning' by a majority of people. Under close examination, however, any such simplistic view of education would not suffice: children learn from their peers as much as (if not more than) they learn from adults. They learn at home and in the playground, as well as by watching television. Fig. 1 caricatures a typical view of the dynamics of society under the spotlight of traditional theories of learning in the absence of computers.

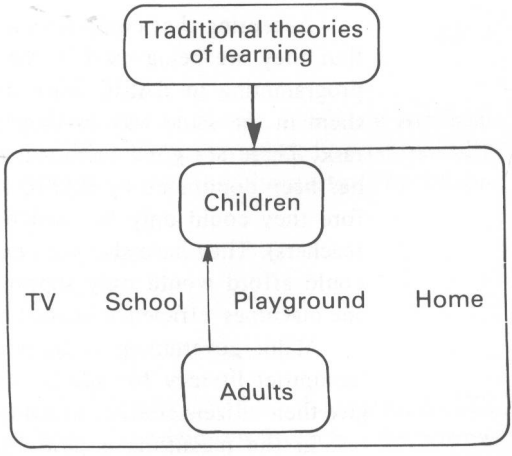

Fig. 1

With the introduction of computers, the spotlight has remained the same, leading to a situation where, on the one hand, Computer Assisted Learning (CAL) packages help teachers to 'teach' different subjects in the school curriculum, and on the other, the writing of BASIC programs teaches children how a computer works. The role of adults, in addition to providing the CAL packages and the BASIC interpreters, is to observe the children's interactions with a view to making an assessment of their abilities for the general work of the school.

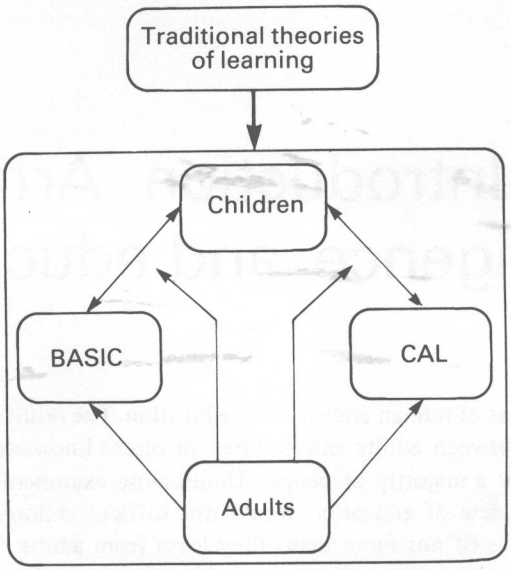

Fig. 2

Accepting that computers are the latest tools invented by man, we can see that they are being used in the same way as many other such tools. Children programming in BASIC learn how to use these new tools while teachers use them in the same way as they use the blackboard: to simplify their teaching task. There are good historical reasons why educational computing up to now has been dominated by BASIC and CAL. Computers have been rare and therefore they could only be used by the privileged class in any environment (e.g. teachers). They have also been expensive, therefore the computers which schools could afford would only support programming languages designed to optimize the machines' efficiency instead of providing for the needs of human users.

Major government initiatives in the western world have concentrated on 'computer literacy for adults', analogous to developing countries' attempts to give their citizens literacy in natural human languages.

In the meantime a new discipline has been active: Artificial Intelligence (AI). It has concerned itself with the study of giving computers abilities usually

associated with human beings (such as the ability to understand natural language, solve problems, play games), as well as learn for itself. In short, AI has been concerned with providing 'human literacy for computers'. More than 25 years' findings from AI are now beginning to affect other human endeavours. In this essay we explore the implications of subjecting the educational environment to the spotlights of AI theories of learning, communication and intelligence. Kahn (1977) has presented some thoughts on interactions between AI and education which are expanded here. Fig. 3, on the first reading, follows the same structure as that of the previous figure, but its components are very different in nature from BASIC and CAL.

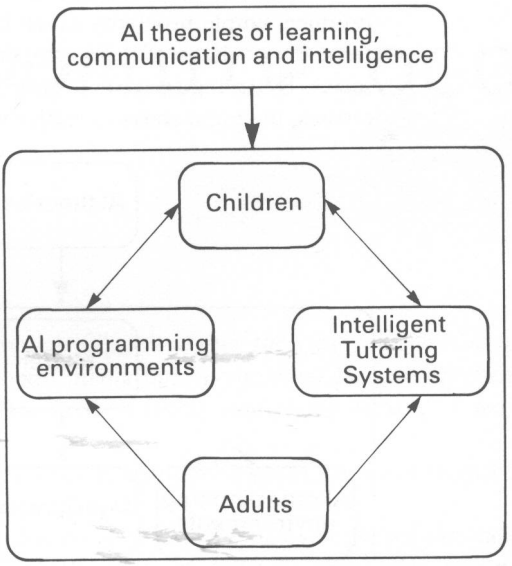

Fig. 3

Intelligent Tutoring Systems (see Sleeman and Brown, 1982) are Artificial Intelligence's answer to CAL packages. While CAL has tended to be basically drill and practice, Intelligent Tutoring Systems (ITS) are diagnostic. The following incorrect subtraction and addition

$$\begin{array}{rr} 170 & 33 \\ -\ 93 & +\ 179 \\ \hline 187 & 102 \end{array}$$

will not result in 'wrong, you lose a point' being printed on the screen. An ITS will diagnose correctly the misconception of the pupil in forgetting the borrow or the carry over.

Artificial Intelligence programming environments are tailored to human beings, minimizing the cognitive load put on a naive user as opposed to optimizing the machine's efficiency. However, AI's contribution to the scene does not stop at enriching the previously existing components. It also introduces new ways of learning and teaching which start to change the overall dynamics of the situation. One such novel way of teaching a subject such as Physics or Medicine would be to produce an intelligent program which would behave like a skilled physicist or a medical consultant (see O'Shea and Self, 1983). The pupils can then observe the knowledge and line of reasoning of the program and learn in a way that they would have been unable to do before.

Pupils can also attempt to use AI programming environments in order to produce simple programs which have a certain level of intelligence. They move from the position of being experimented on to doing the experimentation themselves. By trying to write a program which learns to play a game of noughts and crosses, the pupil starts to realize what learning is.

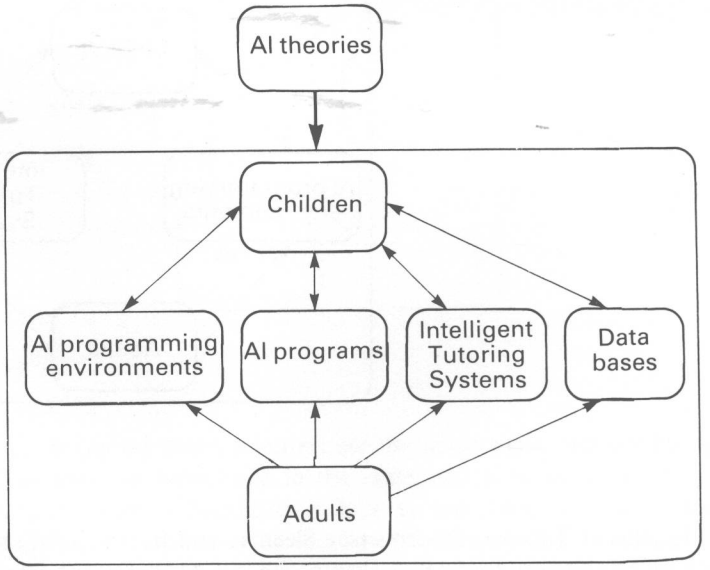

Fig. 4

A detailed study of Fig. 4, considering the probable development of AI in the next few decades, indicates that the difference between a set of programs or a data-base of facts, between an ITS and an AI program is more conceptual than real. In the long term, it will be AI systems which will help people to learn. But to learn what? In a situation where computers have a certain level of intelligence, we do not need to compromise and learn their internal working. Further, having been freed from the artificial problem of how computers work, we can return to the basic objective of education: 'human literacy for human beings'.

PART I

THE WORLD OF LOGO

'Tomorrow's Classrooms' by Seymour Papert argues the case for the role of subversion in education. This complements (and completes) the general thesis based on 'personal discovery' (see Papert, 1980), underlying most of Logo's educational philosophy.

'Why Logo?' by Brian Harvey gives a clear exposition of Logo as a programming language.

'Designing Computer-Based Microworlds' by Bob Lawler shows the most practical contribution of Logo to education in designing computing systems are educational, fun, and which relate to childrens' basic feelings.

'Model Building, Mathematics and Logo' presents the Edinburgh University's interpretation of Logo and reports on the use of Logo in schools by Jim Howe and his collaborators. This paper presents a radically different view to that of Papert, using Logo within the conventional school curriculum. In other words, it advocates an evolution rather than a revolution of the educational system.

'Logo for Teacher Education' by Dale Burnett brings the two alternative views of Logo closer when he uses Logo in Teacher Education as opposed to the common pupil education role of Logo.

'A Very Friendly Software Environment for SOLO' by Tony Hasemer reports on how SOLO (a Logo-based programming environment) was designed and how it has evolved according to the observed needs of naive users. SOLO incorporates a database as one of the basic primitives of the language, going closer to the papers in the next section of the book, those on Prolog. However, it follows Logo's procedural approach.

The researchers at the Open University have spent a great deal of time agonizing about SOLO and how it could be improved. They have collected a vast amount of empirical data from the user interactions with the system, resulting in additions ranging from a spelling corrector, the HELP system, to an auto-debugger. The result is some major sophisticated 'bells and whistles' showing what, in theory, can be added to any programming system given enough time, money and computing power.

SOLO as a practical computing language falls well short of Logo or Prolog. 'It's virtually a subset of Prolog anyway', I was told, together with the news that the Open University course will switch to Prolog in the near future. I hope this will lead to the development of more friendly interfaces for Prolog and the transfer of sophisticated extensions of SOLO into Prolog.

'Modelling Novice Programmer Behaviour' by Hank Kahney shows new areas in which research is needed in extending our knowledge of how people learn programming and what they need.

These last two chapters will remind casual readers of the word 'horizons' in the title of the book.