A second goal which should be pursued in our education (and which is related to the first one) is the development of information handling skills, i.e. children have to learn to deal purposefully with data (information). For, to be able to work with computers (or, more generally, with new technology systems) one needs to know more than just to operate these machines.
Computers will be used for a purpose, e.g. the acquisition of knowledge (exploration, testing hypotheses, learning) or the controlling of processes or the preparation of decision making processes. For these purposes new technologies are instruments in a process of information handling and data processing. The Dutch Advisory Committee for Education and Information Techno logy has pointed to the complementary character of computer science or informatics and information science; see appendix and AEIT (1984).

It should be noticed that this new technology will not only affect the goals and content of teaching and learning processes in schools, and the forms these can take, but it will also create important opportunities for these processes to take place out of school and beyond school age. Unlike other kinds of technology NT fosters demassification and decentralization, making it possible to use an interactive instructional approach tailored to the wishes and potentialities of the individual. The opportunities to receive information or tuition outside the formal educational system are greatly expanded. The traditional school has already lost its monopoly as a delivery system of knowledge. The school of the future also has to take this development in account.

As a fourth point, professions will change, nowadays and in the future, as a concequence of technological developments. We may expect that a majority of professional workers will have to learn permanently. In many countries the so-called 'recurrent education' is already discussed largely. It is a new educational goal to prepare people for lifelong learning.

A final aspect which has to do with the general goals of education is the loss-of-a-job perspective for many young people. A conse quence of this is a decrease of motivation for attending school. We might state it more positively: the information society is also becoming a recreation society, which will have consequences for our schools: how can we motivate children for school and how can we prepare them for a society with plenty of time.

As we have seen, the development of new technologies may have great consequences for the general goals, and therefore for the

computers provide a valuable and sometimes even irreplaceable addition to the repertoire of educational designers and teachers. There are three modes in which the computer can be used as an aid in learning and instruction: tutor, tool, tutee (Taylor, 1980). To function as a tutor in some subject, the computer must be programed; the student is then tutored by the computer while executing the programme. To function as a tool the computer only needs to have some useful capability programed into it (e.g. word processing, statistical and other calculation packages, data bases, spread sheet). Students can then use the computer to help them in a variety of subjects and situations. To use the computer as tutee is to tutor the computer. In this mode it is necessary that the student or the teacher doing the tutoring of the computer must learn to talk to the computer in a language it understands (Taylor, p. 3,4.). A wellknown example is the turtle geometry (developed by Papert, 198O) in which students can interact with the computer in the language LOGO.

From several meta-analyses performed by Kulik et al (a.o. 1981, 1983) on the results of a great number of studies regarding the outcomes of 'computer based instruction' it becomes clear that thus far its major contribution concerns the efficiency of instruction: one needs significantly less time to reach a certain level of mastery. The effect on the learning outcomes per se seems to be far less pronounced. On the other hand, interesting effects are reported in the attitudinal domain: when computers are used, learners are slightly more positive about the content and method of instruction, and show a much more positive attitude towards computers.

Plomp and Van de Wolde (1985) make the following remarks in connection with these meta-analyses: it doesn't seem appropriate to treat all kinds of educational computer use as a single category, as Kulik et al. did. Using a computer in tutor mode e.g. to give feedback in a drill-and-practice situation is not to be com pared with an application in a tutee mode, e.g. computer programing to teach problem solving. These approaches may reflect basically different didactical viewpoints, stressing either receptive or discovery teaching strategies. Whether one will be succesful in evoking a particular learning outcome depends on the whole pedagogical environment of which the computer system is only one element. If a teacher doesn't know how to induce and guide discovery processes in his pupils when there are no computers around, it is not very likely that he will be able to do so merely by introducing e.g. LOGO in his lessons. He will probably end up teaching LOGO just as he would teach BASIC, successively introducing new features of the language, whether or

not they may have any significance to his pupils by that time. In more traditional educational contexts it will be easier to implement tutor mode applications that match expositive teaching strategies.

Therefore, it is important that also attention will be paid to the role of the teacher, as the innovation must ultimately be realized via them. Olson (1984) points to some important aspects. As a consequence of NT the relationship between teacher and students/pupils will change: pupils will learn more independent from the teacher. Do teachers accept this new relationship? Are they capable of 'playing' their new role? Besides this, microcomputers are not yet domesticated sufficiently, i.e. the structure of courseware is such that it is very difficult for teachers to help their pupils when they have problems during their computer assisted learning. We earlier pointed to the problem of the lack of fit in instructional design decisions between teachers and material developers (section 3). To our opinion, Olson is rightly stating the question whether the microcomputer will become teacher's pet or his 'Trojan's horse'.

5. The Role of International Research

In the preceding sections we discussed the effects of New Technologies on society and the content, process and organization of education. Our conclusion can be worded as follows: as a consequence of NT education has to change and with the appropriate application of NT it is, in principle, possible to change education in the desired direction. It is however difficult to predict what will actually happen, as was the case with earlier innovations. Scriven (1974) argues that the most important effects of many innovations are the unintended outcomes, or side effects. Maybe predictions for the near future are possible, as Lias (1982) concludes that initial applications for inventions mimic established uses of whatever they are replacing before becoming innovative.

When we look at the current situation in most countries, we can see that education is not waiting until all questions are answered. Many schools bought computers, with or without financial help from agencies outside the school. Throughout the world there are large differences between countries in the kind of developments, varying from plans controlled by central governments to just grassroot developments. This means that not only at the national level but also at regional and local levels many different decisions are made, which are the outcome of 'political' discussions in which many social pressure groups are involved. As a consequence of

this there is a lot of natural variation within and between countries from which we can learn by conducting research. It will increase our understanding of which goals are pursued, what approaches are working, what changes can be realized, etc.
In order to have maximal profit from this research it should be standardized with respect to the design and procedures. There is a number of organizations, e.g. UNESCO, OECD, IEA* who are already conducting or planning international projects. The UNESCO and OECD studies are aimed at increasing our understanding by gathering information about national policies and by performing case studies. The IEA study (in the planning of which we are involved) has a different approach and is intended to gather empirical data on country-, school-, teacher- and student level. Although this study is still in its planning stage, the aims and designs can already be summarized as follows: The overall aim of the IEA computers in Education Study is to contribute to building a knowledge base from which answers to questions about what and how to use computers in education can be sought.
Education policy makers, curriculum and courseware developers, administrators and teachers acknowledge the existence of computers, but are often unclear as to how computers can or should be used in education. The fact that the study is multinational in nature, covering a range of countries which are in various stages of development with regard to the introduction of computers in education, should be invaluable in helping countries to see the range of alternative approaches that are available as well as the likely effects of various policies and practices. The study will therefore be of considerable interest to countries in all stages of introducing computers into education.

The study is conceived as a two stage investigation. The first stage, approximately three years in duration, is aimed at gathering information from a representative sample of schools at the primary, lower secondary and upper secondary levels in the participating countries with regard to the current state of computers in education. It is primarily descriptive in nature, focussing on how computers are currently being used in new and existing schoolsubjects, the extent of availability of computers in schools, the nature of instruction about computers, and estimates of the effects that the computers are having on students, the curriculum and the school as an institution, as well as other factors influencing the use of computers in schools. Data will be collected via National Case Studies, School Questionnaires and Teacher Questionnaires (as an international option). The

*IEA = International Association for the Evaluation of Educational Achievement

instruments will not only cover background data, present usage of computers, and views and opinions of those involved in this innovation, but also plans for the future.

The results of this study will not only be of considerable value to policy makers, educators and curriculum and software developers, but will also be conditional for the planning of the second stage of the study.

The second stage of the study will have several purposes.
First, it will provide a replication of stage 1 resulting in presenting an evolution of progress on a number of variables. Second, this stage will allow for a verification of the plans of schools in Stage 1. The degree of implementation of these plans will be revealed on variables, such as changes in needs and implementation of plans. The main second stage survey, however, will be relational in nature in that it will seek to determine the relationships between the variables of interest at the levels of planned and implemented curriculum and students' outcomes. This means that data will be gathered from students, regular class teachers, specialist teachers in computers (if there are any in the school) and school principals. The present plan calls for the survey to be conducted at one grade level at each of the following levels: primary, lower secundary and upper secondary education.
An international Centre will be established to coordinate the execution of the study by National Centres in the participating countries. Each National Centre should be assisted by a committee of national specialsits in the field of New Information Technologies in education. It is hoped to use data communication networks to link National Centres with the International Centre and with each other. We hope that this and other international studies like this, or on a smaller scale, maybe using other methodologies, will be conducted in the next ten years, so that our understanding of the innovative process of introducing NT in education will grow.

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Appendix

Information Science vs. Computer Science

This appendix is based on a report which the Advisory Committee for Education and Information Technology (AEIT) presented to the Dutch Minister of Education and Science, March 1984 (AEIT, 1984).
A characteristic of the so-called 'information society' is the presence of large numbers of data, which can easily be made available to individuals via NT-equipment. However, the availability of data does not imply automatically that one has information at one's disposal. The drawing of information from data (or messages) is a goal-oriented activity. There is a fundamental difference between data or messages at one hand and information at the other.
The difference can be learned from the description of these terms.

- 'data' = facts, from which one can draw conclusions which may lead to the solution of a problem (e.g. the inflation rate in FRG in 1983 was x%);
- 'message' = an objectified communication or text, physically recorded, e.g. text in a newspaper or on a tape (e.g. the Ministers noticed that inflation of x% is too high and that the policy of the government needed to be changed).;
- 'information' = the meaning or interpretation which the receiver of data or message(s) attaches to them (e.g.the interpretation which the receiver of the message about the x% inflation attaches to it).

From what precedes it may be clear that there is no direct causal relation between the computer as professor, manipulator and retriever of data on the one hand and information as the meaning or interpretation which one may attach to the available data on

the other. One can speak of an instrumental relationship between the computer and information, i.e. with the help of a computer one can derive information from data and messages (see figure).

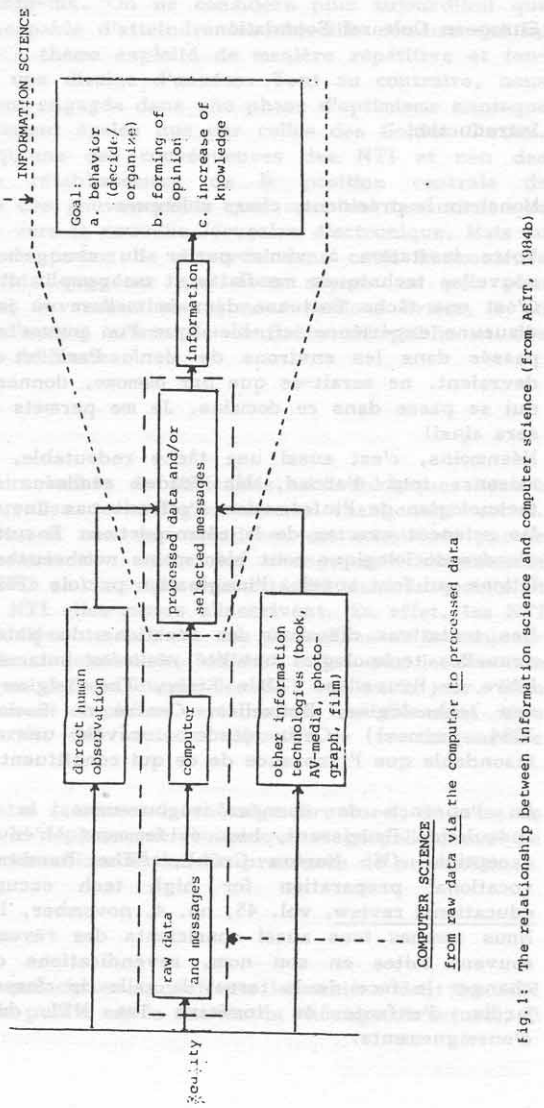

Fig. 1: The relationship between information science and computer science (from AEIT, 1984b)