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ABSTRACT

There are a number of ways in which the educational applications of computers can be categorized. This document focuses on the use of computers in science teaching. It differentiates between such terminology as tutor, tool, tutee, tutorial dialogue, revelatory use, conjectural use, and emancipatory use. The major portion of this paper is a bibliography of articles on the use of computers in science teaching that have appeared in journals during the period 1983-1986. Some of the journal articles listed are primarily devoted to the classroom teaching aspects of science teaching, while others focus on formal research into the teaching process. A summary of the classification of the journal articles is provided in a table preceding the bibliography. (TW)

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COMPUTERS IN SCIENCE TEACHING: A SELECT BIBLIOGRAPHY 1983-6.

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Categorising educational uses of computers

There are a number of ways in which the educational applications of computers can be categorised. Perhaps the simplest set of categories is that suggested by Taylor (1980); in his view, the computer can be used as a *tutor*, a *tool* and a *tutee*.

The computer is being used as a *tutor* when a program "teaches" a student. This is a common use of computers in education, especially at the primary and secondary school level. Some examples of applications of the computer in the "tutor" role are: drill and practice, simulations, and instructional games. The common element in each of these applications is that the computer program leads the student along a pre-determined path. In the case of a drill-and-practice program, the path is very simple; in the case of a simulation or a game, the path may be complex. Nevertheless, the amount of control the learner has is limited.The computer is being used as a *tool* in applications such as computer-managed instruction, word processing, data base management and data collection in the laboratory. Of these applications, the collection, storage and presentation of data in laboratory experiments is of particular interest to the science teacher.The computer has a "*tutee* " role when it is being "taught" by a student. Possibly the best-known example of this application is some uses of the computer language, Logo. This application of computers is characterised by a high degree of learner control. Indeed, the learner is seen as an active participant in the learning process, rather than the passive recipient of pre-packaged knowledge, and assumption which underlies much current work in CAI.

Other classifications of computer use have also been developed, such as the one discussed in Rushby (1979). In this categorisation, computer use is grouped into four headings: the instructional, the revelatory, the conjectural and the emancipatory. This classification has the advantage of separating simulations, an important application in science teaching with computers, from the other instructional applications.

The **instructional** use of computers assumes that the subject matter can be divided into small parts, which can be placed in a coherent sequence; at each stage, there are clearly-defined prerequisities and objectives. In other words, the instructional approach is based (either explicitly or implicitly) on a behaviourist learning theory. Two common applications of this approach are the restricted *tutorial "dialogue"* (in which the computer program chooses from a set of predetermined questions, and accepts a restricted range of responses from the student) and *drill-and-practice* (in which the student practices a narrow skill, such as the addition of two-digit numbers). In the **revelatory** use, the computer program mediates between the student and a model of a real situation. This approach is usually described as using simulations, and is often justified because it saves time and money (and, in some cases, saves students from a potentially dangerous situation). The instructional and revelatory uses of computers correspond to the "tutor" role described by Taylor (1980). **Conjectural** uses of the computer involve the student in control of his or her own learning - much more so than in the two other uses discussed so far. The student is involved in model-building and problem solving. This corresponds to the "tutee" role in Taylor's categories, and, as mentioned above, a well-known example of this approach is in some applications of the computer language Logo.Finally, there is the **emancipatory** use, which frees the student from the drudgery of "inauthentic" labour, such as long, repetitive calculations in gas-law equations. The use of the computer as a "browsing device" also falls into this use: the student uses the computer to browse in data bases.This corresponds to the "tool" role in Taylor's scheme.

Rushby (1979) summarised these four uses of computers to assist the teaching-learning process in this way:

> in the instructional form, the computer is used as a patient tutor; in the revelatory form it is used to mediate between the student and a hidden model or simulation of a real world situation; in the conjectural form it helps the student to formulate and test his hypotheses; in the emancipatory form, it reduces the amount of non-essential work he must do to reach his learning objectives (p. 36).

Patterns of computer use

This bibliography gives a list of articles which have described the use of computers in science classrooms, as indicated by reports in the following journals:

Journal of College Science Teaching
Australian Science Teachers' Journal
The Science Teacher
School Science Review
Journal of Biological Education
Journal of Geological Education
Physics Education
Education in Chemistry
Journal of Chemical Education

These journals are normally devoted to the classroom teaching aspects of science education. In addition, there are journals which focus on formal research into the teaching process. They include the following journals:

European Journal of Science Education
Journal of Research in Science Teaching
Research in Science Education
Research in Science & Technological Education
School Science Mathematics
School Science Review
Science Education

A summary of the classification of the articles found in these journals is presented in Table 1. The data, of course, are based on journal reports, and therefore may not correspond directly with actual classroom use. For example, it is likely that the "instructional" use of computers is under-represented in this table, as teachers are unlikely to report in the literature the routine use of such approaches.

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Taylor, R. P. (Ed.) (1980). *The Computer in the school: Tutor, tool,tutee*. New York: Teachers' College Press.

Table 1
Classification of articles

	Category					Totals
	G	I	R	C	E	
Journal of College Science Teaching	12	6	1	0	5	24
Australian Science Teachers' Journal	3	3	1	0	3	10
The Science Teacher	7	3	3	0	8	21
School Science Review	12	10	20	0	47	89
Journal of Biological Education	6	5	11	0	5	27
Journal of Geological Education	3	5	4	0	8	20
Physics Education	16	8	9	0	14	47
Education in Chemistry	7	8	9	0	20	44
Journal of Chemical Education	37	32	28	0	105	202
Totals	103	80	86	0	215	484
(Percentages)	(21.3)	(16.5)	(17.8)	(0)	(44.4)	(100)

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