Background: A Capsule History of CALL

From the beginnings of computer technology, the research and educational community looked for ways to integrate this new medium, which seemed to promise unlimited applications, into the educational process. The pilot projects of the 1950s culminated with PLATO at the University of Illinois (see article by Robert Hart in this volume).

By 1970 the processing speed and storage capacity of the mainframe computer had increased immensely. At the same time, computer prices were falling—though still high by today’s standards. A new generation of educational software became available: for instance the "learner-centered" TICCIT (see article by Randall Jones in this volume), and PLATO IV, which enabled more than 1,000 students to work simultaneously in a timesharing system. Nevertheless, in terms of the number of CALL programs in use in classroom instruction, little change occurred during these years (Bodendorf 1990, 16).
The high initial costs of the hardware and of programming and the poor quality of too many educational programs worked against wide-spread adoption of CAI. There were several reasons for this. The hardware was unreliable, financial support from industry began to be cut back, and the empirical evidence concerning the effectiveness of CAI was unclear. It seemed to many that CAI—and CALL—programs only reproduced what could be accomplished more effectively and at a lower cost with regular instructional material. Accordingly, enthusiasm and support for many projects left much to be desired (Hope, Taylor and Pusack 1984, 12).

In addition, there were problems with the hardware (e.g., user-friendly system interfaces), and the software was based on behaviorism its accompanying models of mechanized learning, just when the reaching profession was beginning to reject these. Last but not least, many practitioners believed (falsely, as it turned out) that they could merely replace teacher-centered instruction with computer-centered instruction, and that hardly represented progress (Wazel 1987, 16).

The development, in the U.S., in 1968 of the microprocessor initiated a new phase of the computer revolution (though the desktop PC wasn't to be widely available and affordably priced until the end of the next decade and beyond). Not only were the microcomputers much smaller, faster and more user-friendly than the old mainframes, but the graphical system interface developed by Alan Kay and the learning research team at the Xerox Palo Alto Research Center was seen by many as a fundamental change (Walker 1991, 24).

Miniaturization and increased sales volume brought prices down dramatically, making computer technology financially feasible as a mass tool for education. In this second phase of CAI, the computer began to be seen not as a simulation or replacement of the teacher, but as an enrichment of classroom instruction. The computer as a tool for the teacher was born. Not coincidentally, the first authoring languages and authoring systems soon appeared, enabling teachers to design software without being proficient in computer programming.

Since the mid 1980s, a "fifth generation" of computers has been developed, featuring parallel processors. This provided an entirely new means of data processing by connecting many processors (currently more than 64,000), programmed to carry out several tasks simultaneously and to exchange interim results. Successes in this domain have encouraged hope of simulating the processes of the human brain. This has been
described as a move away from procedural data processing and towards logical knowledge processing (Bodendorf 1990). Further trends on the hardware side lie in the constant improvement in hardware functionality (higher processing speed, larger memory, the possibility of natural-language input and output, etc.) and in the combining of media (multimedia / hypermedia applications). On the software side there are efforts to apply the principles and methods of AI to CALL, enabling the development of "intelligent" teaching programs. The goal is to store the information to be taught not just as data, text or pictures, but as knowledge available to the learner.

**Psychological Assumptions**

All of these systems have been based, whether explicitly or tacitly, on learning theories from psychology. Elements of the following three approaches can be found in almost all of today’s CALL programs.

**Behavioral Psychology**

According to behavioral psychology, thought processes can be understood only as a "black box"—we can see what goes in and what comes out, but cannot see the processes inside the box that convert the input to output. Hence learning models can be based only on observation and abstraction of the input entering the brain and the resulting output (behavior). It was on this assumption that programmed instruction (Lane 1964), rested. Programmed instruction was a kind of step-by-step guided tour of the material to be learned, presenting explanatory material, then testing understanding with questions that were to be correctly answered before the student went on to the next part. It was employed in a wide variety of disciplines in the 1950s and 60s, supported by the work of B. F. Skinner, who in turn based his research on the ideas of Edward L. Thorndike.¹

According to Skinner’s concept of "operant conditioning," learning occurs only when the learner’s appropriate reaction to a given stimulus is immediately reinforced. Hence programmed instruction’s emphasis on reinforcement, a tradition to which every CALL program that dispenses praise to the student for a correct answer still pays tribute.
Another important point here is the individualization of the learning process. An individual learning tempo is made possible by the division of the material, which is subdivided into single "learning units," each as small as possible and linked in a logical (to the programmer) sequence. The goal is to make each unit so learnable that the student’s response is likely to be correct about 95% of the time. The correct responses are then immediately reinforced (usually by a statement to the student).

Most programmed instruction was designed in a linear fashion: that is, every user experienced the same set of learning units. "Branching," in which the material presented to the student depends upon the last response of the student, was introduced by mathematician Norman A. Crowder and expanded its repertoire. Branching meant that the material presented to the learner was constantly and directly "steered" by the learner’s achievements in problem solving.

The medium of programmed learning was at first the programmed workbook; but the computer, with its control and interaction possibilities, was as soon as was practicable viewed as the ideal medium for programmed instruction, both linear and branched. The basic concept remained virtually unchanged in spite of the use of modern technologies and is still today the basis of many CALL programs. But the rigid and inflexible structure of these programs barely makes use of the many potentialities of the computer (Bodendorf 1990, 26 and 28 ff.).

**Developmental Psychology**

Developmental psychology deals with analysis of the phases the human being traverses when progressing from childhood to adulthood. It is generally agreed that this is the time one learns the most and the most intensively. In the planning of teaching materials designed according to developmental ideas, the learning stages postulated by this branch of psychology are used as a touchstone. According to Jean Piaget’s theory of ontogenetic developmental phases, the cognitive development of the individual passes through several phases, including:

- play and experiment (sensory-motor phase)
- concept and category building (intuitive-prelogical phase)
• analysis and generalizing (concrete-vivid logic)
• abstract and inferential thinking (formal-abstract thinking)

This theory also provides the psychological foundation for the understanding of a didactic function for illustration and visualization (Schulmeister 1989, 31). The difference between the developmental and the behaviorist approaches is primarily that in the former the learner is granted more initiative. The learners are to manipulate the material as independently as possible and discover the basic principles themselves, resulting in an increase in "discovery learning." This approach assumes that the material to be learned will be worked through more intensively and that success in learning will increase (Bodendorf 1990, 26 ff.). The limitations set on this method by the computer could very well be considerably lessened by CALL programs written in "hyper"-mode.

Cognitive Psychology

In stark contrast to the behavioralists, for whom external behavior is everything, cognitive psychologists believe that it is necessary to understand inner mental states (i.e., storage and organization of knowledge, generation of new knowledge, and so forth) in order to explain human cognitive capacities and learning patterns. From this basic assumption can be seen its close connection to developmental psychology, which takes the ontogenetic development of cognitive capacity as its object. Research results in cognitive psychology and developmental psychology have influenced to a considerable extent the development of modern operating systems and user interfaces.

J. S. Bruner attempted to describe cognitive operations by differentiating between three methods of representation for thought processes: enactive, ikonic (Bruner’s spelling) and symbolic. Enactive refers to the representation of thought processes in concrete-motor activities, for example, knowing how to drive a car; ikonic relates to thought processes activated by perception and "mental pictures" of objects, for example, recognition of faces. Finally, symbolic indicates entirely oral forms of representation, for example, knowing the words of a memorized poem.
These methods correspond roughly to Piaget’s developmental theory, but shift the focus to the transfer of cognitive processes into medial acts. Enactive-ikonic operating systems and user interfaces (e.g., Macintosh, Windows™) have contributed considerably to making the computer more user-friendly, a result Schulmeister attributes to their replication of human development: “They provide the learner with easier access to still unfamiliar new activities through a variety of operational methods and visual-cognitive operations that should be familiar to the learner from his or her own development” (1989, 33).

Cognitive psychology is also closely linked research in the field of AI: questions of representation, acquisition, recall and application of knowledge by humans are essential to the creation of “intelligent” computer programs.

**Preliminary Results**

To what extent, then, does CALL live up to the expectations the FL teaching profession has for it?

The problem that arises in answering this question is that the evaluation of CALL programs is no easier than the evaluation of teaching methods in general. The literature reveals the following results:

- Increased learning efficiency: the same learning success with up to 30% less time and effort (Götz and Hafner 1992, 58; Bodendorf 1990, 71)

- Reduced expenses in education and training: computers on-site eliminate the need for travel and missed work (especially relevant for professional or in-service training). (Bodendorf 1990, 72 ff)

- Positive side effects of becoming familiar with the computer (Götz and Hafner 1992, 58)

In these projects, CAI was often compared to conventional teaching strategies. This kind of comparative evaluation is not without controversy, since most research experiments are conducted under the assumption that it is possible to control all other variables while changing only the teaching medium (Thom6 1989, 38). Even the efficiency
advantages of computer use "proven" statistically by psychometric studies are at best
tendencies; they cannot be understood as objective results, since objectivity, validity
and reliability for these procedures are limited.

Thomé (1989, 226 ff) lists some further failings of such comparison studies:

- The complexity of the teaching situation is insufficiently considered. Variables such
  as the Hawthorne effect (positive effect of exposure to something new per se,
  without its being necessarily better), student and teacher attitudes, and the effect of
  CAI on different learning styles are almost never included.

- Only a narrow definition of effectiveness is used. For example, the memorization of
  facts is overemphasized.

- The measuring instruments and criteria for comparison are specific to the computer
  medium, and hence the results are not generalizable.

- The research results are valid only for the particular CALL program under study
  and no general statement can be made about the medium as a whole.

Thomé further observes that the use of different learning material results in different
patterns of performance, but does not necessarily lead to differences in the level of
performance.

It can be concluded that comparison of the efficacy of one medium over another can
hardly lead to objective results. It is possible only to analyze individual programs
precisely and to evaluate and compare them based on specific criteria.

With her large evaluation list containing 221 criteria, Thomé reviewed eight German
CALL programs for spelling, grammar and word processing for various age groups. All
programs tested revealed major deficiencies in pedagogical and design quality. Similar
alarming results were found by Legenhausen and Wolff (1988, 106) after their analysis
of the value of the computer in foreign language instruction. This negative situation is
still continuing, according to a report by Desjardins, Martin and Walti (1992, 167). After
a critical analysis of forty-six CALL programs now on the market, they concluded: "The
programs for German as a foreign language currently available do not justify their
purchase price.” Often the same old technically, linguistically and pedagogically outdated programs were still being offered for sale. More than fifty percent of the CALL programs Desjardins, Martin and Walti evaluated contained defects serious enough to make their successful use in teaching questionable.

Such a series of negative evaluations from recent years suggests that the present generation of software is not living up to the high expectations of the profession. However, this does not justify the conclusion that the computer should be excluded from foreign language teaching and learning. Rather, it is essential to concentrate on the above mentioned specific advantages of the computer in order to employ this new medium in accordance with its potential.

In the meantime, we have seen a great leap forward in our understanding of the computer as a tool in foreign language teaching and learning. It is essential that research findings be put into practice, so that justified pride in thirty years of CALL will not turn into a “look back in anger” at an equal number of years of ignorance of all too many software producers.

Translated by Elke Schneider

Notes

1 For an overview of Skinner’s ideas see, for example, his About Behaviorism, New York: Knopf, 1974; and Skinner for the Classroom; Selected Papers, Robert Epstein, ed., Champaign, IL: Research Press, 1982. On his predecessor see Thorndike, Edward L., Human Learning, New York: Century, 1931.


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