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Ian G. Pirie
*University of Wollongong*

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by

I.G. PIRIE and L.G. BRIGDEN

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P.O. Box 1144, WOLLONGONG N.S.W. 2500, AUSTRALIA
tel (042)-282-981
telex AA29022

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*I. G. Pirie and L. G. Brigden*

*ABSTRACT*

This paper examines what is wrong with current CAL research and its literature. The principal problem is that CAL research has developed horizontally, but not vertically. This is reflected in the literature which contains a plethora of specific implementations of CAL but few attempts to draw any generalisations from these that might advance our understanding of CAL. This is attributed to the fact that two fundamental questions about CAL are not asked; those questions being "When should CAL be used?" and "What constitutes good CAL?". The absence of these questions is, in turn, attributed to a false bias amongst CAL researchers which leads them to be more concerned that their work uses computers than that it has direct educational benefit.

Keywords and Phrases: Computer aided learning, CAL, CAL research, good CAL.

CR Categories: 1.3

I. G. Pirie is a lecturer in Computing Science at the University of Wollongong.
L. G. Brigden is a Research Assistant to the Working Party on CAL at the University of Wollongong.

## 1. Introduction

Many would agree after having read the literature on CAL over the past few years that, with the exception of a few rare papers, there would be no point in re-reading it. The literature on CAL only keeps one informed as to what projects have been undertaken while it does nothing to significantly advance understanding of CAL. Most papers on CAL are merely documents of personal experience recording the author's own particular philosophy of CAL and how he implemented it in practice. As Watkins (1981) expressed it in a review article, "The papers are, on the whole, catalogues of terminals, languages, biographies and acronyms".

There has clearly been a horizontal expansion of CAL research without any corresponding expansion in the vertical direction - an unhealthy state of affairs for any field of research. It is a symptom of this unhealthy state when people say that "CAL is still in an early experimental stage" (Burkhardt, 1982). They have been saying this for a good twenty years and don't look like being able to say anything different for some time to come.

## 2. A Lack of Fundamentals

CAL research lacks depth because some fundamental questions are not asked. Questions such as "When should CAL be used?" and "What constitutes good CAL?" are not merely avoided - they are simply never considered.

It is because questions such as these are not considered that you may read the literature on CAL without really learning very much about CAL. You will learn how this or that piece of computing equipment was used to implement these or those lessons in fulfilment of this or that personal philosophy of CAL. You may also learn how the project was 'evaluated' by comparing the results of standardised tests administered to both an experimental and control group. But about CAL itself and what actually happens at the concrete level of a student interacting with learning material displayed on

a terminal screen you will learn very little. Few CAL researchers display any interest in this concrete level. They are much more interested in expounding philosophies and implementing them with the tacit assumption that whatever you present to a student on a terminal screen constitutes CAL. In a strict sense, of course, this is perfectly true; but the problem is that the matter is left there and few seem to question the quality of what is presented.

This lack of interest in "computer aided learning" explains the dearth of good quality CAL material; a dearth which is, ironically, almost universally lamented. And a hundred more papers which merely document a personal experience in implementing CAL will not get us any closer to answering fundamental questions about CAL or producing good CAL. This does not mean that there should be no documents of personal experience in the literature, only that there should be more than just that. There should be the attempt to derive from the personal experience some contribution to our knowledge, both general and specific, of how to make effective use of a computer-driven video screen for teaching purposes.

In the category of general knowledge there should be papers which address themselves to the first fundamental question given above, that is, "When should CAL be used?". Such papers should compare the computer with other educational media and then discuss, in the light of its peculiar characteristics, those circumstances under which the computer would be the most appropriate medium to use. To our knowledge only one paper (Leiblum, 1979) has been published which gives serious attention to this topic.

In the category of specific knowledge there should be papers which address themselves to the second fundamental question: "What constitutes good CAL?". Such papers should deal with the techniques of arranging and presenting learning material skilfully and effectively on a terminal screen. Here the situation is somewhat more promising: a number of papers have been published in this area (Jenkin (1982),

Nievergelt (1979) and Spitler (1979)). However, there is something unsatisfying about the papers. They don't seem to get anywhere. They often adopt an abstract approach and avoid getting down to specifics. Although Spitler (1979), for example, mentions that "there is a variety of successful methods for arranging instructional material", he never seems to get around to actually naming them.

Then there is Jenkin (1982) who speaks of principles of 'screen management' and recommends the organisation of screen material such that a student has "a clear perception of the different functions" of the material. But helpful as his advice may be in certain cases, it surely embodies too narrow a conception of good screen design to be applied across the whole range of lessons that may be written. On the other hand, there is the work of Nievergelt (1979) which is promising precisely because he does get down to specifics. He is prepared to make some definite recommendations about the style in which learning material should be presented on a terminal screen. (We also know of one CAL advisory unit which has issued a booklet dealing with the standardisation of CAL dialogues. This is, at least, one attempt to tackle a small section of the problem.)

One might be optimistic that at least a start has been made in the vertical direction. One might indeed be optimistic if there were not two good reasons for being pessimistic. The first is that there is still a very strong horizontal tendency in current CAL research. This means that although a start may be made towards some vertical research, it is quite unlikely that it will be taken up and developed by the CAL community at large because of its bias towards *the computer* rather than to *learning* referred to later. The second reason is that even if it is developed it probably will not develop in the right way. This is because in most instances it is not begun in the right way. It is either simply begun, or begun by theorizing at the general abstract level, without reference to the particular concrete level.

The diagnosis suggests the cure. There should be a keener observation of CAL

lessons and their real life interaction with users while keeping in mind, and attempting to answer, the two fundamental questions about CAL given above. "When should CAL be used?" can then be answered by observing which uses of CAL are appropriate in practice and which are not. Some generalizations can then be drawn from these observations to form the foundation of a screening procedure for eliminating inappropriate uses of the computing medium. "What constitutes good CAL?" can be answered in a similar fashion by observing which techniques are effective in the presentation of learning material. These techniques are then generalised as far as possible and from them is derived a set of practical guidelines to assist the CAL author in organising and presenting the learning material of his lesson.

This "observation" approach has been used by the authors over the past two years when viewing existing lessons in many situations. As a result of this approach it was possible to produce a set of guidelines for **prospective** CAL authors to help them determine, before starting, whether or not CAL is an appropriate choice. The approach also lead us to delineate a range of screen presentation techniques which, if used correctly, should result in an effective CAL segment.

The real advantage of such guidelines and the presentation techniques is that they refer to certain things that the author should or should not do in the process of authoring which will increase the likelihood that the CAL segment will be successful. This is a significant step forward from the currently used post-evaluations of CAL lessons which have the distinct drawback that they can only be conducted after the lessons have been implemented; that is, after a considerable amount of time and money has been spent on them. With post-evaluations it can never be known until **after** the effort has been expended whether or not success has been achieved. If the lesson turns out to be good, well and good; if it turns out to be a flop, that's just too bad. The use of the guidelines is **not** a replacement for post-evaluation, rather they complement one another. Currently **only** post-evaluation is used. Surely there has been

enough of this hit and miss approach whereby the wheel is discovered, rediscovered, and then rediscovered yet again? Surely the time has come for drawing some constructive vertical generalisations from the vast expanse of horizontal experience?

It is our belief that the time has come, indeed that it is long overdue. Hence, we intend to present, in a series of papers to follow this one, the fruits of our researches which have been conducted using the approach indicated above.

### 3. The Researchers

A significant cause of the unhealthy state of the literature of CAL must be attributed to the researchers themselves. What are their motives for being involved in CAL, for conducting CAL projects and for writing research papers? We contend that the primary motive behind most computer aided learning researchers is the desire to work with **computers**, while the desire to produce something of educational benefit (i.e. 'aided learning') takes a subordinate secondary place. This is clearly the reverse of what it should be. Notice that our claim concerns priorities. We do not deny that both desires are not, or should not, be present, only that there should be a strict hierarchy: learning first, computing second. As things stand at present it is computing first and learning second. This false bias towards computing has distorted the literature on CAL giving it breadth without depth. While some may attempt to deny that such a bias operates amongst CAL researchers, a good deal of support can be adduced for this claim from a study of the literature itself.

Consider, for example, how often the following are referred to as advantages of using CAL lessons: that they offer self-paced, impersonal yet individualised instruction with immediate feedback of results. It might be correct to assert these as attributes of CAL but it is a completely separate question as to whether they are **desirable** attributes and therefore advantages. Do students really want self-paced, individualised instruction? Do they really want impersonal instruction? The emotional bias of those who extol these attributes of CAL as advantages is obvious. One might, if one were

inclined, or sufficiently biased, extol the attributes of an intelligent parrot in the same way, asserting that the parrot promotes learning by its constancy in the repetition of facts, by its decoration of the learning environment and by its cuteness (especially appealing to the younger students). The question is not whether the device **has** the attributes but whether the attributes are **desirable**.

Pursuing this point a little further, we may also note that there is a suspicious lack of critical examination of the attributes themselves. For example, what is meant by saying that CAL offers self-paced instruction? That you may sit at a terminal whenever you like for as long as you like and that you are at liberty to flip to the next display whenever you feel so inclined? Firstly, it is questionable whether the claim of unrestricted access to computing resources is true in view of their relatively high cost. And secondly, all that is being claimed here for CAL is hardly distinctive. Books, on the same citeria, would have to offer the ultimate in self-paced learning. Furthermore, books possess many advantages that CAL lacks. They have easy to read black on white print, there is space for making notes and underlining, and they are cheap, completely reliable and portable. It is curious that none of these advantages seem to have been harped upon quite as much as those attributed to CAL.

Then there is the claim that CAL offers individualised instruction. But again, exactly what is meant by this? Essentially it means that a CAL lesson can assess each student's learning needs through his responses and present him with material appropriate to his own level of understanding. Firstly, the production of such lesson material is **very** time consuming and expensive. The provision of a number of different levels of approach to a subject matter could pobably be much more cheaply and effectively met by giving students access to a library well stocked with books that parallel the set texts. This has the added advantage that the material is in a convenient and familiar form. Secondly, it seems quite a futile exercise to program this sort of sensitivity into a computer when there are human beings, called teachers, that already have

it. Moreover, whether or not a teacher is available, it may be argued that it is better to encourage the student to develop a sensitivity to his own educational needs.

It should be made clear at this point that we are not suggesting that some perfectly valid claims cannot be made for CAL; only that the ones customarily made are not well considered. Nor are we suggesting that books are superior to CAL; only that each educational media has its own peculiar attributes. It is then not a question of one medium being superior to another but rather a question of which medium is most appropriate in a given situation. There are some very attractive and quite distinctive attributes of the computing medium: it is flexible, dynamic and interactive. One should, therefore, be selective about implementations of CAL so that these attributes are appropriate to the given learning situation and are then exploited to the full.

But to return to our earlier theme, there is another, perhaps more obvious betrayal of the underlying motivation of CAL researchers, which can be discerned in those papers which list the various justifications for the use of CAL. At the end of such lists, which include the 'advantages' already referred to, there is generally added something to the effect that familiarity with the computer is, in itself, a good thing. There is something suspicious about the inclusion of this last justification of CAL. It is usually included on the grounds that computers will encroach further and further onto all aspects of our lives and we would, therefore, do well to have some familiarity with their use. As true as this may be, it is still not a valid argument for the use of CAL in general. Indeed, it seems rather, to be a valid argument for the teaching of computing science and/or computer awareness.

It is evident that much of the work reported in the literature has been based on an unquestioning acceptance of the 'virtues' of CAL as well as a tacit assumption that CAL represents the 'modern approach' and that because it uses computers it must automatically be effective. Hence, many have thought it a good idea to try their hand at CAL - and not thought much further. In particular, they have given no thought as to

whether the computer was an appropriate medium for the purposes at hand, or whether some other medium might actually have been more appropriate. It appears that this question is mysteriously overlooked and its answer (for it must at least be answered implicitly) pre-empted by the sheer presence and availability of the computer.

## 4. Conclusion

The purpose of this paper has been to diagnose the ills of current CAL research. The principal ill is that it lacks depth despite its considerable breadth. The only way to give it depth is to begin to ask two fundamental questions about CAL: "When should CAL be used?" and "What constitutes good CAL?". In the final analysis, the reason these questions have not been asked before and the fact that the literature languishes in its present unhealthy state must be traced to the CAL researchers themselves. It is evident that the primary motivation of these researchers has been their interest in **computing** with their interest in **learning** taking a subordinate secondary place. This situation simply must be reversed if there is to be any significant improvement in the pattern of CAL research and any advancement in the understanding of CAL.

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