CAL in Construction: Attitudes to Learning

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Abstract

This paper reports on a CAL development project at the University of Hong Kong in the Department of Surveying. Initial developments were aimed at assisting student comprehension of construction technology but quickly developed in the direction of allowing students more control over their learning as well as the depth and breadth of the subject area covered. An attempt has been made to link the CAL package to problem based learning (PBL) in the undergraduate teaching programme. This paper describes the initial design concept of the CAL package and then discusses the mode of implementation.

Initial results from the pilot study are reported indicating 1) a good deal of student interest in the programme, 2) little or no problem with the interface, 3) greater conceptual challenge than expected, 4) a tendency for students to revert to guessing rather than planned responses, 5) a need for better video segments and graphics which held a clearer relationship to the associated text resources and 6) more conceptually robust text based resources.

Students' responses are compared against the objectives set by the developers for changes in learning style. Possible inhibitors to these changes are identified, including 1) persistent staff and student misperceptions about the purpose of the programme, 2) insufficient initial staff endorsement and commitment to using the programme and 3) a consequential lack of sufficient richness in the on-line materials to properly support PBL style investigations. The paper concludes with a review of future directions for the project.

Introduction

In mid 1990 a joint multimedia development project was initiated between the University of Hong Kong, Department of Surveying and the Educational Technology Centre at the City Polytechnic of Hong Kong (now City University). The idea was to develop a programme which would allow students of Construction Technology courses to experience the process of planning a construction project within the relative security of an electronically mediated learning environment. An MS-DOS based interactive video programme was successfully developed and alpha-tested. Unfortunately because the programme was originally developed for use with expensive digital video cards, the cost of making it accessible to more than a few students at a time was prohibitive, making adequate delivery unworkable. Furthermore, data from the alpha-test indicated that, while the activities and functions of the programme were helpful to the user's learning efforts, the programme was difficult to work with over extended time periods due to the low resolution of the user interface. Consequently the user interface has been refined and the programme has been redesigned for CD-ROM based delivery running under Microsoft Windows 3.1.

Originally the programme was developed to provide students with a set of exercises which would allow them to test their understanding of procedures and concepts learned during lectures. However as various aspects of the interface were developed and tested it became clear that by enriching the information resources within the programme it could be used to support the development of more sophisticated problem solving and critical thinking skills. The discovery was timely as the department was seeking to revise its curriculum to place greater emphasis on these skills. A decision was made to investigate the possibilities by taking an action research approach (Zuber-Skerritt, 1992) to studying the effect of programme use on student learning. This involved working through a cycle of redevelopment and testing with various groups of students through a number of iterations. This paper describes the design features of the programme, the planned course of intervention and the outcomes after the first round of student testing.

Methods

Courses in Construction Technology, offered to both first and second year students in the Department of Surveying at the University of Hong Kong, characteristically involve complex concepts of an extremely pragmatic nature which are not easily learned within heavily didactic educational environments. In order to address this problem, the department has begun to investigate the possibility of taking a Problem Based Learning (PBL) approach to the curriculum, in particular with respect to the design of required studio work in years one, two, and three. The benefits of PBL with respect to an improved student capacity for analysis and critical thinking are well documented (Boud and Feletti, 1991; Chen et al., 1994). Cawley (1989) in particular has demonstrated its effectiveness in sustaining a high degree of student motivation and achievement within the context of a single course in mechanical engineering. However, as PBL invokes a fundamental change in both the context of learning and the manner in which it occurs (Engel, 1992), it was expected that, when first exposed to it, Hong Kong students would have no less difficulty adjusting than students elsewhere (Woods, 1994). Furthermore, Hong Kong students have a tendency to employ achievement oriented learning strategies (Biggs, 1987) which invoke unusual combinations of deep and surface approaches to learning (Watkins and Biggs, 1996). Hence their expectations of the teacher-student relationship vary considerably from the expectations of western students, making it difficult to predict their response to PBL methods based on experience elsewhere in the world. As such, the authors were forced to consider the possibility that confusion, negative responses and lack of student enthusiasm might become acute.

In an attempt to control this eventuality, initial student responses to the introduction of PBL elements and processes in the studio programme were monitored via survey and interviews. As expected the feedback gathered indicated a fair degree of discomfort with the process. Students appeared to lack confidence in their ability to independently solve preset problems by accessing, interpreting and applying information and principles learned primarily through a self directed investigation of the resources currently available. Pre-university training did not seem to have supplied them with the learning skills needed to confidently take full responsibility for their own learning process.

In response, the educational computing software described below was devised. Its primary aim was to expose students to problem situations and related information in a way which would support investigative learning, build student confidence in self-directed problem solving and ease the transition to PBL. Related but subordinate to that aim was the intention to develop learning materials which would reflect and support the aims of the revised curriculum as outlined in the course document. That is, it would help:

> (a) to enable students to develop their intellectual, analytical and critical abilities and to exercise these abilities within a study of the land conversion process;
>
> (b) to create a climate in which students can extend these abilities and which the development of the facilities of independent logical thought and critical judgement are encouraged.
>
> ...

(d) to establish an environment within which students feel able to examine critically the established and evolving aspects of the surveying profession within the context of their study of the land conversion process as a whole.

(McKinnell, 1992, p.54)

In particular, the stated aims of the PBL approach to the first, second and third year studios needed to be addressed.

The (studio) work set will require students to apply taught material to the solution of problems and may also pose problems beyond the taught part of the course. It will be directed towards developing a deeper understanding of the land conversion process as a whole whilst allowing students to test their abilities and understanding of professional skills and techniques within the context of the process.

(Projects will) require students to tackle a significant problem generally from a broad perspective and can extend over a substantial period. They develop the students' abilities in analysis and problem solving, collecting, collating and presenting information and in professional skills and techniques...Projects may pose problems beyond the taught part of the course and thereby provide motivation and stimulus for investigation and a problem solving approach.

(McKinnell, 1992, p.79)

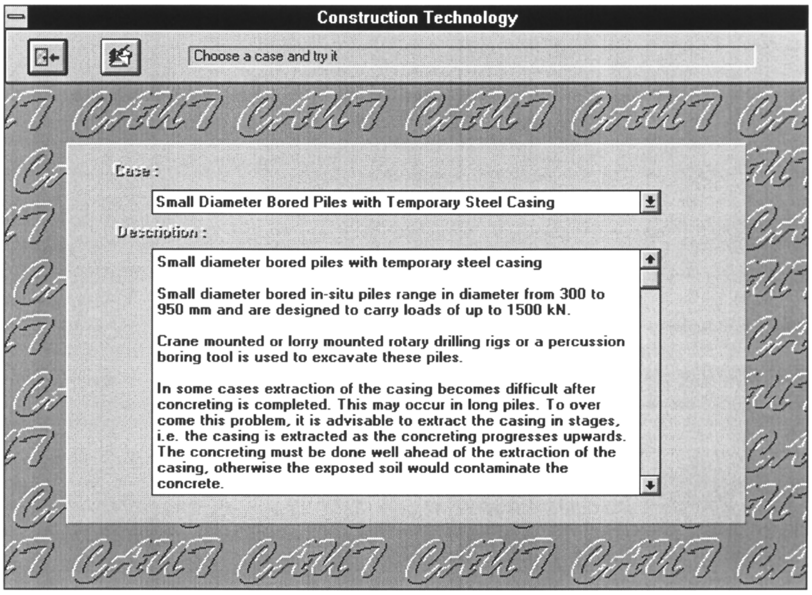
Pedagogical Considerations

To encourage investigative learning it was decided from the outset that the programme would have limited if any tutorial value. Rather, a loosely constructivist (Duffy and Jonassen, 1992) design was chosen which begins with a central problem and subsequently requires students to identify and effectively sequence a set of procedures. Rather than guide students towards a 'correct solution' students are expected to construct their own solution by accessing a range of information relating to each procedure. Students make decisions about the appropriate use of various procedures based on the information available and its applicability to the current problem context. While some directive feedback is available in the form of one possible solution, the solution provided is deliberately inelegant and can easily be improved upon. Students are warned of this before engaging in the programme and are told that they will get more credit for imaginative solutions than for duplicating the suggested solution.

Interface Design

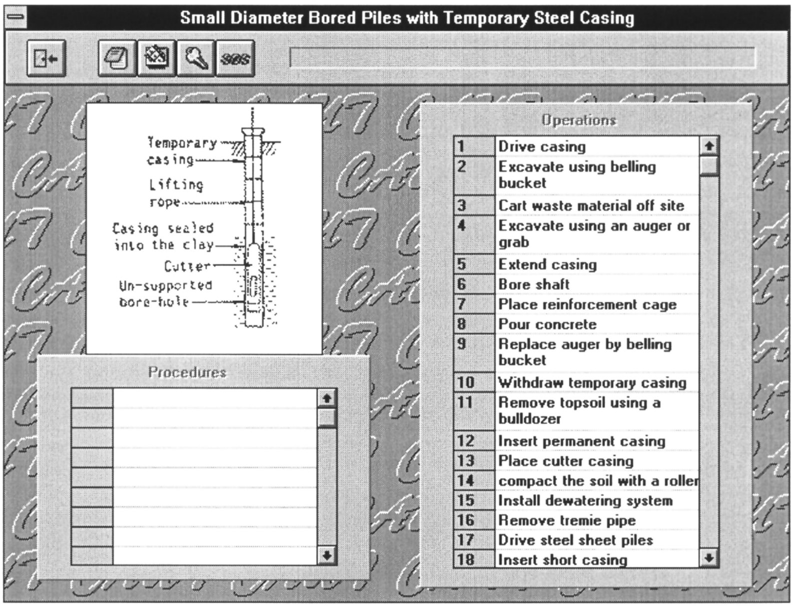
The initial programme interface was kept as simple as possible to minimise the amount of time required to master it. It consisted of a startup screen (figure 1) which presented a problem scenario

Figure 1: Startup Screen



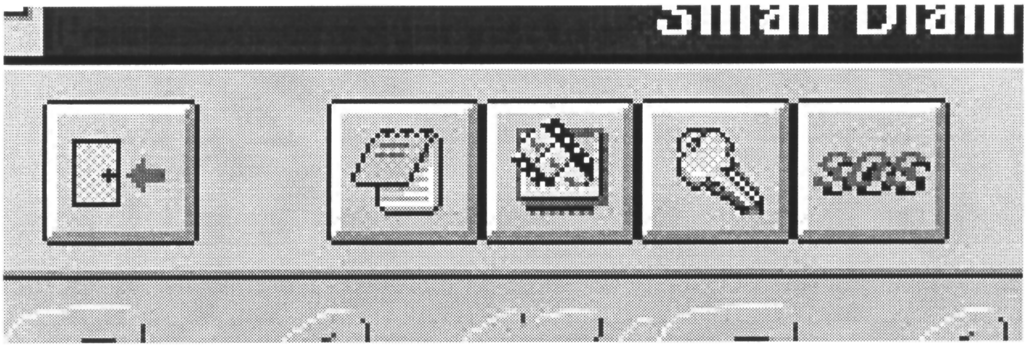
and offered several selectable alternative approaches to solving it. By way of example, the first case focused on various methods of piling. It presented a problem scenario which involved the building of a hospital under certain conditions and asked students to select a piling method appropriate to the case. Having selected a method, students were presented with a work screen (figure 2) consisting of a scrollable list of procedures on the right side and a blank work list-form on the left.

Figure 2: Work Screen



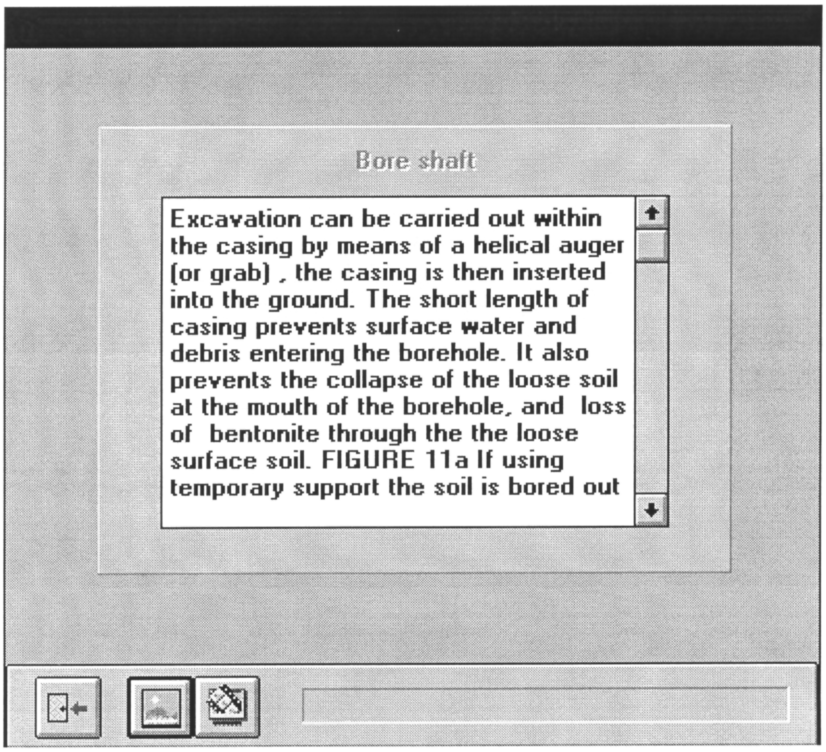
Several clickable function icons were arranged across the top of the screen including a notepad, solution key, video button and return to the startup screen (figure 3).

Figure 3: Function Icons



Students were simply required to select procedures from the given set and to place them in sequence in the work list-form by clicking and dragging. They could obtain information about a procedure by double clicking it. An information window of supporting text was thus opened, which might have any combination of graphics and video accessible by clickable icons attached to it (figure 4). Having once selected and placed a procedure, students could edit their decision at any

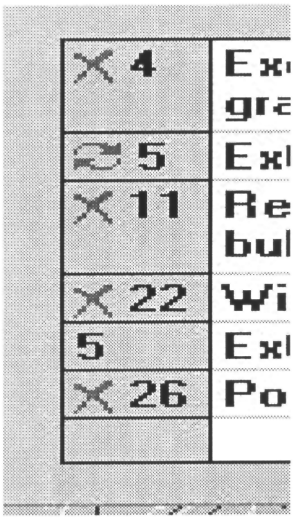
Figure 4: Information Window



time by clicking on any procedure placed in their work list. A short list of selectable items appeared that allowed them to cut, paste, insert or pack items within the work list.

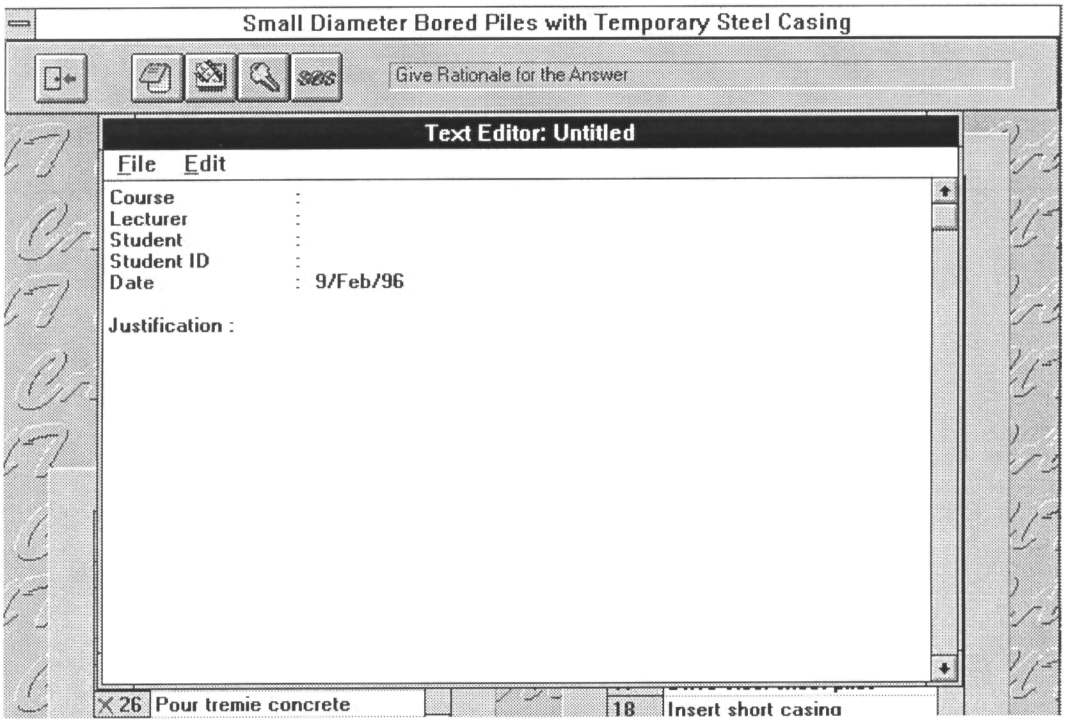
Once students arrived at a solution they could click on the key icon at the top of the screen and immediately receive feedback in the form of clues similar to those used in the well known board game, MasterMind. The procedures in their working list would either be tagged with a red 'x' indicating an incorrect procedure; a pair of red arrows forming a circle indicating a correct procedure incorrectly sequenced; or nothing at all indicating a correct procedure in the correct sequence (figure 5). Students were then able to revise their lists or click on the key icon again to

Figure 5: Selection and Sequencing Feedback



receive a suggested solution. Having received the solution students could compare their answer. On the basis of that comparison, they could thus decide to change or not change their solutions. Bearing in mind that the solution presented to them was not necessarily the best one, students were then required to click on the notepad icon to call up the built-in word-processor and to write a rationale for their solution (figure 6). Their solution list and rationale could then be printed and submitted to the course tutor for comment.

Figure 6: Text Editor



Problem Selections

At the time of the initial trial only one full case had been developed, although currently several others are under consideration. Cases are considered and selected 1) from the existing database of case studies; 2) on the basis of their relevance to existing course materials and prerequisites; 3) on the availability of relevant graphic, video and text material; 4) which are suitably complex and; 5) on the strength of their relevance to local practice.

Results

Individual Trials with Interview

One on one trials were conducted with five third year students who were assumed to be familiar with the subject material of the initial case. Students were asked to work through the programme while talking with an interviewer about what they were doing and what their expectations were. All expressed an interest in the programme. They were particularly surprised to find they had forgotten much of the first year material that the problem addressed. They anticipated being able to arrive at a solution relatively quickly and, as the trial progressed, became powerfully aware of the gaps in their understanding. All of the five students interviewed spent more than an hour arriving at a workable solution, indicating that a fairly substantial degree of informational complexity accompanied the relatively simple activity of sequencing procedures. All made comments about how they thought having access to this programme from the outset would have helped them to secure their understanding of the topic and improve their ability to apply their knowledge to a particular situation.

They described the interface as simple to understand and easy to use with little exploration needed to understand the purpose of the exercise. Most felt that supporting documentation was unnecessary as the interface is almost entirely mouse driven and there are no hidden functions. Two suggested that a quick reference card with a short description of the purpose of the exercise may help to start students on the right track. It was particularly interesting to note that even though these students were told that there was no single correct answer they still depended heavily on comparing their answers to the suggested one before feeling confidant enough to submit a solution. The rationales they provided for their solutions in the notepad were also weak. They tended to describe what they perceived to be the textbook reasons for their solutions and not to reflect the ways in which they had considered contextual elements. They all found the programme enjoyable but suggested that it could be made more interesting by supplying better video clips, more sophisticated graphics and lateral hypertext links between explanations behind related procedures.

Field Test

The programme was subsequently field tested with fifty second year students who were allowed to access the programme in the departmental computer lab in groups of seven over a period of a week. They tended to work on the programme in groups with a high degree of interaction and discussion. Most of the responses of the interview group were consistent with those of this group. However, several other tendencies became evident. One was to try and solve the problem simply by trial and error. That is, in spite of instructions to the contrary, they guessed at solution sequences, making very little use of the information resources, and then checked them against the suggested solution. Having seen the 'correct' answer, they would then try to duplicate it. Subsequent rationales in the notepad were nothing more than attempts to explain why the suggested answer was the best one. We suspect that this response was largely due to the fact that, as indicated in the individual trials, proper use of the programme takes time and effort. Consequently, unless some form of extrinsic incentive is attached to the activity, students are unlikely to see the value in it or to take it seriously enough to commit the required time and effort.

Interface Inadequacies

The programme interface was evaluated during the alpha-test using a combination of the method described by Hart (1993) and the criteria outlined by Marsh (1990). A number of interface inadequacies were also noted.

- Video windows tended to be too small for message coherence to be maintained.
- Printing of solution lists was problematic and could only be achieved by using the printscreen function.
- There was no option for students to save their work, forcing them to complete an exercise before leaving the program.
- There was no built in facility for communicating with the tutor, which is a feature that would greatly enhance the feedback process.
- Graphic materials were unsophisticated and divorced from the text material. It was suggested that larger, more detailed graphics should be provided that had hot-links allowing students to directly reference related text material.

Discussion

It became evident during the initial trial period that the above mentioned interface problems needed to be rectified before the programme could be fairly evaluated for its usefulness in facilitating students' transition to working within the PBL paradigm. It also became apparent that the on-line resource material was in general neither robust nor stimulating enough to sufficiently sustain student interest. Consequently a number of revisions have been made to the interface and a substantial amount of new material has been collected for inclusion.

The new version of the programme, which was tested in the fall semester of 1996, includes a detailed case description page at the front end of the programme, full screen still graphics with hot-links to related glossary items and full print and save capabilities.

Apart from the problems of student perceptions of the purpose and value of the programme, several other difficulties became evident. The most prevalent was the difficulty in getting the staff concerned with teaching related courses to endorse its use. Most perceived it to be a supplementary resource which students may access should they wish to. They saw its purpose as being highly content related and did not see its value in terms of supporting the development of critical thinking and problem solving skills. More critically, they did not fully appreciate the intended use of the programme as a means to facilitate student acceptance of and adaptation to PBL. As such, getting the academic staff to be responsible for specifying content to clearly understand the type of resources needed proved extremely difficult. This led to a lack of richness in the material made available for inclusion and a lack of robustness in the overall programme content. Only after the first round of testing did the main purpose of the programme become clear to those involved in trialling it. It is hoped that this will lead to effective revisions and improved specification of future cases.

Conclusion

While implementation of the programme has not yet proven entirely satisfactory with respect to meeting our stated aim of facilitating the transition to PBL, a number of encouraging outcomes of the trial have thus far lead us to believe that aim is achievable. In particular, student response during individual testing indicates that, given appropriate briefing and proper contextualisation, the programme may serve to enhance critical thinking and confidence in problem solving as well as encourage student reflection on topic comprehension. To that end the programme will be tested and revised through a number of iterations of the implementation, evaluation and revision cycle associated with action research (Zuber-Skerritt, 1992). This will involve testing the programme with a variety of students who are have been exposed to the PBL processes within the Surveying curriculum.

Our intention is to survey student attitudes towards PBL with and without having used the programme to see if programme use has any effect on student expressed attitudes towards PBL methods, as well as to examine ongoing student performance within the developing PBL context. However, in order to do this effectively, a far more robust and coherent set of problems need to be defined and a richer set of on-line resources needs to be developed. Finally, we expect to eventually develop problem cases in a variety of other disciplines interested in adopting PBL methods to see if the results noted in Surveying can be generalised beyond the discipline.