

Evaluation of CAL in higher education Geography

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Abstract In recent years the promotion and incorporation of computer-assisted learning courseware has been a feature of many Geography departments in higher education in the UK. There is little disagreement that this development needs to be thoroughly evaluated to ensure quality and effectiveness. However there has been a lack of rigorous evaluation in practice. A detailed illuminative evaluation of 120 Geography students using focus group interviews and an attitude survey reveals that CAL packages remain unpopular with most learners. This can be attributed to the content and presentation of packages but it is also suggested that contexts of use and perhaps staff disinterest are explanatory factors. Some gender-based and age-based attitude differences are noted. This type of evaluation is of greater use to curriculum developers than objective-led approaches.

Keywords: Computer; Courseware; Geography; Illuminative evaluation; Mediated; Questionnaire; Undergraduate

Introduction

A substantial amount of educational software for use in higher education is being continually developed by universities, teaching and learning initiatives, and private companies. Geography teaching has been a major benefactor of the 'IT revolution' due to the relative ease with which a large number of basic skills, information and complex analytical procedures central to Geography curricula may be assisted by computers (Proctor & Donoghue, 1994). Some see the combination of graphics and animation as uniquely appealing for teaching Geography (Batty *et al.*, 1985) and, as a result, Computer-Assisted Learning (CAL) packages have been written for use in the teaching of topics such as meteorology, cartography, hydrology, environmental hazards, social survey design, economic change and so on., Information Technology has been heralded both as a liberating force and as the answer to the increasing demands of higher education (Henry & Rafferty, 1995), yet much of the pressures to improve computer-based methods have come from the outside. Timms *et al.* (1997) list these as: the growing emphasis on lifelong learning, the spread of telematics and distance

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learning, teaching quality assessment, new patterns of student recruitment and finance, reductions in funding and the Dearing Commission of Inquiry into the future shape and funding of HE. In addition they list institutional responses; staff development programmes, budgetary devolution, the explicit statement of strategies for teaching, research and information, and the closer attention paid to efficiency and effectiveness.

In 1993, Laurillard commented that, although the use of IT-based media over the previous 20 years had been prodigious, it had not been matched by an understanding of it, because there had been an emphasis on development and use rather than on research and evaluation. Five years on, the evaluation of courseware has become a major area of research, however, as Jacobs (1998) notes (p. 3) "...common experience with technology-assisted curricula confirms that it is far from the general rule that ongoing evaluations are carried out by teachers once a piece of courseware has been implemented in a real learning situation." In his opinion there is a distinction to be made between 'assessment', which is undertaken by reviewers, scholarly journals and other subject specific publications (which is often subjective and judgmental), and 'evaluation', which is a systematic quasi-objective review process of the value and effectiveness of a piece of courseware. Examples of evaluation in the literature (e.g. Haddon *et al.*, 1995) have mainly been conducted by workers from within the CAL design and development community.

The incorporation of any new addition to the delivery of higher education should at all times be subjected to rigorous summative and formative evaluation. According to Tergan (1998) the items that should be examined in the case of educational software are: the subject matter (relevance and appropriacy), the learner, the instructional methods and the technology itself.

This study represents an evaluation of student attitudes to CAL by researchers who locate themselves outside the CAL community and would consider their views to be less value-laden.

The paper describes an evaluation of the use of CAL packages by students in the Geographical Division (BSc Geography and BA/BSc Combined Honours Earth Science) at University College Northampton, United Kingdom. Consideration of staff opinion was avoided as, in the words of Donald & Dension (1996), it is the students who are "the ones who experience the curriculum as designed by institutions and enacted in classrooms and are in the best position to describe how they interpret and experience the curriculum they are required to take." CAL is a broad term that encompasses a wide range of IT-based materials used by learners and the research was not directed towards the evaluation of any specific module.

Computer-assisted learning in higher education

Much of the development and promotion of IT-based learning in HE in the UK has been undertaken by the following initiatives; the Teaching and Learning Programme (TLTP), the Information Technology Training Initiative (ITTI), the Computers in Teaching Initiative (CTI) and, in Scotland, by the Learning and Teaching Dissemination Initiative (LTDI). They provide expertise to all who are interested in the effective use of learning

technologies. This development has generally been driven by the desire to increase teaching efficiency. There is however, considerable controversy over the assumed effectiveness and efficiency of CAL. As most projects have not included a mechanism for performance measurement there is limited quantified data, yet Coopers and Lybrand (1996) in their evaluation of the TLTP, concluded that there is currently little evidence that IT-based courseware can yield increased productivity in teaching, learning or assessment. However, Davies & Crowther (1995) claim that:

- CAL increases student motivation;
- CAL facilitates active learning;
- CAL facilitates experiential learning;
- CAL is consistent with student-centred learning;
- CAL leads to better learning.

It is claimed that multimedia courseware offers a more stimulating and motivating learning environment compared to traditional methods. Vroom (1964) relates increased learner motivation to increased learner performance. Enhancing motivation, by rendering a product more engaging to the learner is a major task facing designers of courseware.

Active learning is desirable because it engages the student as an interactive partner. Student thought and response is provided with immediate feedback, whereas experiential learning involves the student learning by doing tasks for themselves. CAL technology allows the simulation of reality so that the student becomes a decision-maker on the basis of previously learned concepts. Disadvantages of CAL include the inevitable difficulty of modelling the complexity of the real world and the fact that students have sparse knowledge of the design, assumptions and limitations of the models. Students who have not developed a model themselves, but simply change the values of pre-programmed variables, may gain an impression of a neatly functioning world '*bereft of difficult decisions and compromises implicit in constricting explanations of it.*' (Webb, 1991).

CAL approaches are believed to be consistent with student-centred learning. It has been suggested that giving control over the system, process and content to the user increases the motivation to learn (Becker & Dwyer, 1994). Students are able to utilise the flexibility with respect to what is studied, when it is studied, the navigation paths followed and the pace of study. Hannafin (1992) notes that the provision of coaching or 'guided control' by the teacher is necessary as total learner control could result in unstructured browsing with a consequent decline in learning.

Finally, CAL is described as leading to better learning. This is an ambitious claim and can be evaluated with respect to the educational objectives. Williams & Nicholson (1994) comment that often courseware adopts a 'drill and practice' approach resulting in superficial understanding of the subject matter and little deep understanding or the use of sophisticated cognitive skills. On the other hand Sherwood (1990) suggests that verbal interactions between students when using simulation software facilitates higher-order thinking, as students readily interact with their peers in order to solve problems.

Methodology

Evaluation of courses in HE should ideally be an illuminative process that is conducted by the teacher on a continual basis (Barnett, 1992). The most basic evaluation methodology is the classical 'objectives-lead' approach or so-called 'pre-test/post-test'. This is a 'blackbox' approach in which the learning strategy is quantitatively evaluated with reference to success in the achievement of curriculum goals and objectives. This is most commonly measured by student assessment results. This type of evaluation is limited as, firstly it fails to provide insight into why a programme may or may not be working, and secondly that individual learning strategies cannot be separated from the influence of other components (e.g. lectures, seminars and reading). The need to evaluate the entire process of learning led to the development of illuminative evaluation. This involves intensive study of a teaching and learning programme as a whole: its rationale and evolution, its operations, achievements and difficulties. The CIPP (Context, Input, Process, Product) approach proposed by Stufflebeam (1974) is composed of four evaluation stages which consider the importance of input and output but also process and context.

In order to do this several data collection techniques must be employed. In this study a form of 'triangulation' approach was used. Multiple methods can capture more of the complexity of human behaviour than any single method approach and can increase the confidence that the researcher has in the findings if different methods agree. In this study semi-structured interviews (focus groups) and questionnaire analysis were used. In this case four (A, B, C and D) six-member groups were sampled as follows:

- Group A 1st Years (two mature students 1, 5, three males 1, 2, 3, three females 4, 5, 6);
- Group B 3rd Years (no matures, two males 2, 3, four females 1, 4, 5, 6);
- Group C 2nd Years (no matures, two males 1, 2, 3, 4, two females 5, 6);
- Group D 2nd Years (three matures 1, 3, 5, two males 1, 3, four females 2, 4, 5, 6)

Meetings lasted 20 minutes. A series of prompt questions were devised beforehand but were not strictly followed. Finally the interviews were recorded, transcribed and then comments coded. Special attention was paid to the following ideas, as suggested by Kreuger (1994):

- context of language;
- internal consistency of opinion;
- frequency and extensiveness of comments;
- intensity of comments;
- specificity of responses;
- big ideas.

A questionnaire was designed to assess student attitude. Attitude was quantified using a Likert summated rating scale (Likert, 1932). Items for the questionnaire were selected from an original list of 60 presented to a pilot group of Geography students. The 20 items with greatest discriminatory power were retained (see Robson, 1993). Nevertheless those items discarded because of almost total respondent agreement are of value to curriculum development.

Table 1. Some comments from Focus Group Interviews on CAL use

Group A

I do find CAL useful. (1), A1

I use it to back up the class notes, use one to back up the other. (2), A1

I have used it a little bit, though not enough. (3), A1

I did one like that for Chemistry, they're quite good, they teach you how to use relevant things in your course. (4), A6

As a response to the question [DO you prefer CAL to lectures?] No, its better than lectures, you feel you are being taught by a computer rather than. there's no interaction with the teachers (5), A6

Group B

We were directed to look at it, I don't know if anybody did. (6), B4

Dr S told us to do it to supplement (*sic*) the lecture he wasn't doing; but I don't think many people did it. (7), B2

I did one, it was only because I was with H and she was really keen; it was all right. (8), B1

[Do you enjoy using CAL?]

No, it was useful though; it did supplement what we learnt. (9), B5

It was dead slow though. (10), B2

It takes forever to go through it. (11), B2

If it told you how long it takes to begin with it would be better. (12), B1

If it says this is going to take four hours you are not going to bother, are you? (13), B2

I'm not motivated enough. some people probably are, but I don't think I am. (14), B4

[Do you prefer CAL to lectures?]

When somebody is explaining it to you I understand it more than if I was to read it for myself. (15), B5

There are more opportunities to ask questions. (16), B1

If you did it you would probably print it off, put it in your file and never get round to reading it. (17), B2

At least with a lecture you write it down and read it as you are going along. (18), B2

Group C

A bit tedious. (19), C2

... because there's no one actually talking to you, you don't take it in. (20), C3

... not as motivating. (21), C4

I just say 'I'll do it later', you never actually do it as its in your own time. (22), C4

It is just like reading a book really. (23), C1

I'd rather read a book than sit in front of a screen and read off a screen. (24), C2

I prefer lectures – you feel like you are learning more, not clicking on, clicking on, it always takes longer. (25), C2

Its easier to interpret what a lecturer tells you, you can just ask. (26), C4

Group D

I think CAL has good and bad points. (27), D3

Its quicker if you just read a book. and time for us is the most important thing. (28), D1

We have spent more time on CAL than anything so far. (29), D3

At one stage we had the computer going and the video and the lecture. (30), D1

[Why do you think you used CAL?]

We want to hear real people. (37), D5; because its new and trendy and someone told him to. (31), D1

... as long as everyone is up to using it. I have problems just to keep up with the computer. (32), D5

... yes. there was relevance, but only after, not during. (33), D4

I just bought the book. (34), D1

I am still miles behind because of it. (35), D3

No one was there when you wanted to ask a question. (36), D6

We want to hear real people. (37), D5

If we had wanted to go to the OU we would have. (38), D1

The questionnaire was distributed to 124 students and completed in class time. A total of 120 completed forms could be used in the analysis. The sample was drawn approximately equally from the three years of each of the degree courses and each year had five mature (25 years +) students. There was equal representation of males and females which mirrors the gender division of the whole cohort. A thorough evaluation should aim to identify if certain groups exhibit coherence in learning style — with the view to assessing whether the adoption of particular teaching methods disadvantages learners. Turkle (1984) notes that computers have exercised an almost obsessional attraction to a minority of students whereas others have traditionally been identified as less computer literate. It has been suggested that computer work could disadvantage female students (Chen, 1986; Rosser, 1989) and also mature students (who have had less exposure to IT in earlier stages of their education), however, other research (Enochs, 1984; Abouserie *et al.*, 1992) has questioned this conclusion.

At UCN students use GEOCAL packages as support to lecture programmes. Most of the content of relevant GEOCAL packages are introductory and therefore are undertaken mainly during first and second year courses. Timetabled hours on each course range from 2 to 6 h. So maximum timetabled usage of CAL in each year (on both courses) would be as follows:

- Year One — 16 h
- Year Two — 16 h
- Year Three — 8 h

Recently staff have begun to introduce and recommend the use of on-line learning resources. These interactive study programmes are mainly based in the USA (e.g. Meteorology at the Department of Atmospheric Science, University of Illinois <http://covis/atmos/uiuc/edu/guide.guide.html>). At the moment are introduced by lecturers and student are expected to treat these as background reading. It is hoped that increased speed of WWW connection may eventually make them suitable for class use.

Results and discussion

Focus Groups

Categories of focus group responses were divided into those concerned with general IT skills, CAL, IT provision and tuition, and distance based learning. The overall impression is that an IT culture has been firmly established. There was agreement that IT skills were relevant to teaching and learning practices and enhanced student employability. *'I don't think I could get by without a computer (B5) If you know what you're doing . . . in the world of work, the amount of places you go to and they ask you, do you know Word? Can you use WordPerfect? (B1) Absolutely vital, you can't do without them.'* (D1). These opinions were shared by all members of the groups.

Groups were prompted with questions about the use of CAL packages, for instance: Have you used CAL packages? What is your opinion of them? Do you prefer CAL to lectures? Some of the responses to these questions are listed in Table 1. Responses reveal that UCN Geography student resistance to CAL is high. It is not perceived as particularly interactive (e.g. 20, 5, 15,

16, 36, 37). This view was expressed intensely and frequently and students agreed and reinforced each other's statements with eye contact and smiles.

The term 'interactive' suggests a two-way transfer of information between the user and a central point and is used to promote most, if not all, multimedia packages (Heath, 1995). Students could not equate the predictable interactivity between the learners and the computer interface with the more spontaneous relationship with their teacher. Davies & Crowther (1995) have remarked that CAL offers a '*. . . more stimulating and motivating learning environment.*' (although the authors do concede that '*. . . there is a temptation to overplay the motivational capability of multimedia.*'). Group members commented that they did not find CAL motivating (7, 14, 21, 24). A problem with CAL is that the on-screen appearance (quality of graphics) is far inferior to commercial entertainment-based multimedia products or CD-ROMs that students use outside college. CAL packages often already seem '*. . . a bit dated.*' (A6), even though most were written within the last four years. Educational software incurs high resource costs in developmental stages and the long review process and often sluggish adoption by staff can lead to obsolescence by newer technology once it is finally incorporated into the curriculum.

There was an opinion shared by some students that the use of CAL is fashionable (31) and the province of young staff who are the '*. . . most taken in by the technology*' (D5). Some students were concerned about the length of time that CAL packages take (10, 11, 12). Modules do inform users of the time taken for completion, but this was thought by some to be inaccurate.

Participating mature students were more supportive of CAL and felt that CAL was useful to '*back up the class notes*' (A1). This view, together with 7, suggests that it was not fully integrated into taught courses but staff were recommending use for supplementary purposes or even only informing students of its existence.

Gunn & Brussino (1997) have noted that '*. . . teachers with full workloads and satisfactory outcomes from existing methods of course delivery are not necessarily motivated to venture into the uncharted waters of technology-based developments. . .*' and often direct students to investigate CAL themselves in their own time.

Some students felt restricted by the use of CAL: '*we don't have much chance to do things other than what it does*' (D3). Magrass & Upchurch (1988) have commented that '*. . . computers can implement a centrally imposed curriculum with rigidly defined rules and dependence on binary logic.*' In addition others felt that modules frequently were not relevant to their courses: '*. . . we did not know much about air pollution that they were talking about*' (B3). As no national curriculum exists in HE modules are written and field tested by a small group of authors (almost all subject deliverers themselves) from a limited number of institutions. As a consequence, particular idiosyncrasies of the designers' own taught courses have emerged. This makes them less useful for widespread use.

Considerable criticism of College facilities was voiced. This is generated by the ownership of home computers (all focus group members had their own PCs), which often have a higher specification than College machines

and also the fact that most CAL packages are accessed via the College server which is slower than machine-based software. Concern was repeatedly directed towards College printing facilities '*... new printers would make a big difference.*' (C1), '*I don't bother to print here.*' (A2). This is inevitable as PCs outnumber printers by about 10–one and the output (generally dot matrix) is of much poorer quality than on-screen documents and images. Computer rooms were criticised for the lack of air conditioning and other environmental factors (e.g. *It is too hot and humid, even in winter*' (C5), '*the noise of the printers is unbearable*' (C1).

It is incontrovertible that educational software will not be readily accepted by students in part-replacement for human teachers unless software can offer something, which even the best human teacher cannot consistently offer. Jones *et al.* (1997) state that almost every publication on learning technology, the Dearing Report included, hails it with enthusiasm and yet '*...we still witness broad resistance to courseware.*' Proctor & Donoghue (1994) suggest that '*new ideas must deliver substantial benefits to the learning process and be popular with the people it affects.*'

Table 2. Questionnaire results

| | Level of agreement * | | | | |
|--|----------------------|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 |
| I prefer to work on my own | 1 | 22 | 40 | 56 | 1 |
| I study and learn better at home | 7 | 24 | 24 | 57 | 8 |
| Conditions in the classroom environment are important for my concentration | 3 | 18 | 17 | 64 | 18 |
| I prefer to work by discussion with my colleagues | 13 | 41 | 36 | 19 | 11 |
| I find it difficult to get motivated by CAL packages | 0 | 2 | 25 | 70 | 23 |
| I often find computer instructions to be confusing and a hindrance | 3 | 25 | 37 | 38 | 17 |
| I prefer essays to short answers/multiple choice question | 10 | 31 | 41 | 24 | 14 |
| I prefer interactive media to books | 1 | 28 | 39 | 40 | 12 |
| I find CAL motivating and stimulating | 20 | 64 | 27 | 5 | 4 |
| IT skills rapidly go out of date | 2 | 11 | 10 | 65 | 32 |
| The IT provision in the college is good | 1 | 16 | 32 | 39 | 30 |
| I work on CAL only in class time | 10 | 29 | 62 | 19 | 0 |
| I prefer CAL to lectures | 24 | 59 | 21 | 16 | 0 |
| Too much use of computer means you can relate less to people | 0 | 36 | 27 | 45 | 12 |
| I cannot see the relevance of CAL to my taught course | 3 | 60 | 15 | 32 | 10 |
| The IT rooms in college are pleasant environments | 20 | 48 | 31 | 16 | 5 |
| I would rather miss a CAL session than a lecture | 0 | 10 | 18 | 75 | 17 |
| I would rather be taught for my degree than read for it | 21 | 38 | 45 | 15 | 1 |
| There is not enough discussion based tuition | 0 | 11 | 39 | 55 | 15 |
| I would like to use computer based learning more | 17 | 56 | 34 | 12 | 2 |

* 1 strongly disagree; 2 disagree; 3 neither agree nor disagree; 4 agree; 5 strongly agree

Questionnaire

There were three types of statements (related to learning preferences to CAL use and to IT facilities) in the attitude survey. Results (Table 2) correspond well to the findings of the interviews indicating that the group member samples were representative. Overall student reactions do not concur with the intentions and objectives of CAL. Seventy-eight percentage of respondents agreed that motivation was difficult and 69% preferred to miss

CAL than a lecture. The relevance of CAL to the students' course was unclear to 33% of students. A high proportion (61%) felt that they would not like to use more CAL. Respondents claimed to have a desire to be taught rather than follow independent study (13%). However when they were required to complete work outside timetabled sessions the home was the preferred location and this probably reflected a dislike of college study environments and facilities (68% said that conditions were important for study).

Differences in attitudes towards CAL between subgroups were examined for statistical significance using a Kolmogorov-Smirnov test. Males indicated a stronger preference for CAL type assessments — suggesting a gender-based difference in learning preferences in the sample. Mature students were more likely to find CAL stimulating and were less critical of the college facilities. Older students were also significantly more likely to prefer to work away from home where in some cases disturbances and responsibilities are greater. Differences in year groups were surprisingly minor, although first year students were significantly more critical of CAL and second years found CAL less appealing.

Final comments

Much evaluation of courseware has been based on whether or not it crashes or whether or not it is innovative or attractive (Jacobs, 1998) whereas what needs to be assessed is whether it actually helps a student to learn effectively. Student learning is highly complex and evaluators are required to assess the influence of many variables, for instance, the software and student learning preferences but also the capabilities of the hardware, rooms, attitudes of staff, appropriateness of content, timing of sessions, etc.

The intention of this evaluation was to consider the learner attitudes to CAL as part of a larger holistic curriculum evaluation. The inclusion of student contributions to the formal evaluation of courses and methods is commonplace in most, if not all, higher education institutions in England and Wales (Barnett, 1992), yet this is controversial. Newport (1996) comments that he '*... can think of few tasks as complex as evaluating teaching in Higher Education.*' This is because there is still great difficulty in providing an answer to the question 'What is good teaching?'

There are many tools for evaluation, however, an illuminative method, that yields information on the context and process rather than just whether the learning outcomes have been achieved is of greater use to curriculum developers. Findings can be used to indicate areas on which to concentrate in order to improve the learning process. Evaluation is essential if a greater use of educational software is to be encouraged by government directly imposed by institutions as a result of the recommendations in the Dearing Report (Dearing, 1997). Despite the efforts of CTI and TLTP, progress in the development of CAL in higher education has been regarded as disappointing by some (Jones *et al.*, 1997). The Dearing Report maintained that, while huge sums have been invested CAL remains '*... far from being embedded in the day to day practice of learning in most higher education institutions.*' (Chapter 3, Section 61). This is seen to be a consequence of staff

resistance '... the main reasons that many academics have had no training and little experience in the use of communications and information technology as an educational tool.' (Chapter 3, Section 61). This brief study indicates that learners are not convinced either.

Principles and concepts taught in Geography (systems approaches, model building, cartography, GIS) can benefit from the application of IT, however, the findings of this study reveal a mismatch between student perception of the value of CAL and that of the developers. Some explanations of this could be poor environmental factors, poor facilities, a lack of importance placed on CAL by staff, or more fundamentally the fact that the CAL approach does not equate with many of the students' preferred styles of learning. There appears to be homogeneity in student attitude with only a few significant differences emerging between gender-based or age-based subgroups in the sample.

It is inevitable that the incorporation of Computer Assisted Learning methods in HE Geography (by designer software packages or on-line learning resource) will continue. As a result there exists the need for rigorous evaluation using illuminative methods to ensure the quality and success of the teaching and learning process.

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