Int. J. Engng Ed. Vol. 17, No. 6, pp. 502–511, 2001
Printed in Great Britain.

0949-149X/91 $3.00+0.00

Computer Assisted Learning in Engineering Degree Programmes: A Survey at the End of the 20th Century

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The findings of a 1999 survey of Computer Assisted Learning (CAL) materials in use in engineering degrees is described. The survey concentrated on the UK with a smaller exercise conducted in Australia, and explored packages used, modes of use, interactivity and student attitudes. The survey revealed widespread but not prevalent CAL material use amongst the academics surveyed, who appreciated the pedagogical benefits but were less convinced that the right material is already available. They prepare their own material as often as selecting an off-the-shelf package for use in the early years of degree programmes, especially for coursework and tutorials. Time-tabled use and the incentive brought by assessment appear important in maintaining positive attitudes amongst students. Comparing major English-speaking HE markets in the UK, Australia and US revealed how little material is implemented across borders, suggesting the availability of a wealth of materials yet to be exploited.

INTRODUCTION

COMPUTER ASSISTED LEARNING (CAL) material is now available at levels from pre-school to Higher Education (HE) degree programmes. In engineering degrees, where numeracy and computer literacy are pre-requisites for study, it is not uncommon to see examples of CAL activity. Particularly prevalent is the software generated under the first two phases of the UK Higher Education funding bodies' Teaching and Learning Technology Programme (TLTP). These phases focused on producing CAL materials in all disciplines, with a total investment of over £45 million since August 1992 through the three phases of the TLTP. The Programme has been principally responsible for developing the culture of CAL material use within UK universities with substantial influence in engineering degree programmes. A count of Phase 1 and 2 TLTP projects shows around one in five were of subject-specific interest to HE engineers if there is inclusion of related areas such as mathematics and programming. The TLTP is not the only source of engineering CAL material; in house generation accounts for a substantial proportion, usually within commercial authoring shells, while commercial packages are also widely available and often valuable for both learning and industrial application. The 'teaching resources' series published by the Computers in Teaching Initiative (CTI) Centre for Engineering [1–5] lists almost 400 electronic resources available for teaching engineering and mathematics subjects.

* Accepted 29 April 2001.

It is clear, therefore, that CAL use is now a mature application of information technology in HE engineering but, while material is widely available, its use is far from commonplace.The 'not-invented-here' syndrome, entrenched scepticism of the benefits and the steep learning curve associated with choosing, installing and implementing the most suitable materials have all been put forward as reasons why this occurs. It was with this latter issue particularly in mind that EASEIT-Eng (Evaluative and Advisory Support to Encourage Innovative Teaching in Engineering—www.easeit-eng.ac.uk), a TLTP Phase 3 project, was established, leading to the completion of this survey as part of the EASEIT-Eng project.

The primary concern of the third phase of the TLTP is to encourage the implementation of existing computer assisted learning materials in UK HE rather than further development of materials. The EASEIT-Eng project's aims include the creation of standardised procedures for the evaluation of CAL material used for delivery of elements within engineering degree programmes as well as the completion of contextually sensitive evaluations using these procedures. Loughborough University leads the project consortium comprising of the UK Universities of Heriot-Watt, Hertfordshire, Hull, Northumbria, and Surrey. The consortium also initially included the CTI Centre for Engineering at Queen Mary & Westfield College. The CTI programme has now been superseded by the creation of the Learning and Teaching Support Network (LTSN) from which the LTSN Engineering Centre, (www.ltsneng.ac.uk), hosted by Loughborough University has become a consortium member. Further input from the UK

Professional Engineering Institutions complements the consortium's work in a sector where the accrediting role of the Institutions gives them a special and high profile status.

The survey of CAL materials in use at degree level within engineering together with attitudes towards such use was conducted during spring 1999. This paper sets out the findings of this survey, setting them in the context of previous similar work and of a similar but smaller scale exercise conducted in Australia. Conducting of the survey involved the wide distribution of questionnaires amongst the UK's approximately three hundred engineering departments in approximately one hundred institutions by mail over the web. Fifty-nine departments in forty-eight institutions returned a total of eighty-two responses, representing a reasonable coverage at least at institutional level. Comparable HE sector surveys [6, 7] reveal a similar return rate considering that the EASEIT-Eng survey concentrated on the engineering community that forms less than 10% of the whole UK HE sector. Of those respondents whose addresses declared a particular departmental affiliation, dominance of the Mechanical, Electrical & Electronic and Civil Engineering departments was relative to the dominance of these subjects within the sector.

QUESTIONNAIRE STRUCTURE

The first section of the questionnaire explored access issues for academic staff, including access to computers, the Internet and to technical support for the implementation of CAL materials. The second section concentrated on an analysis of views on CAL software itself. The third section allowed respondents to name any packages they had used together with details to describe how and with whom they had used them. The final section set three simple questions intended to explore the connection between students' attitudes towards CAL material and the level of support available to them and to the academic tutor.

ANALYSIS OF RESPONSES FROM UK ACADEMICS

Access

The statistics concerning access are symptomatic of the importance of computers to every aspect of an engineering academic's role today. Every respondent had computer access in their workplace. For all but 2 this included PC access but almost half of the respondents had Apple and/or UNIX access as well. Every respondent had easy Internet access and every HE respondent had that access directly from their desk.

The vast majority of institutions, thirty-nine out of forty-eight, appear to have invested in dedicated support for the use of technology in learning and teaching. Fifty-eight respondents indicated awareness of a person responsible for learning technology in their institution and forty-nine of these had spoken with them. Interestingly, within one in ten institutions, different respondents disagreed on whether such a person existed so while the infrastructure may be in place there would appear to be problems with the communication of institutional commitment to CAL.

Table 1. Current views on software for teaching and learning.

POSITIVE	%
It aids the learning process	84
It enables sharing of teaching materials	65
It promotes learning independence	63
CAL offers quality software simulations and courseware	54
It supports the management of my teaching materials	48
It is a way of surviving high student staff ratios	44
It addresses the problem of mixed abilities	41
It makes me more productive	32
CAL delivers well-structured, comprehensive teaching material	30
NEUTRAL	%
Students expect it	32
It is inevitable	30
NEGATIVE	%
CAL packages produced by others do not meet with my needs	26
I haven't the time to get to grips with such packages	20
It changes too quickly	11
It is too expensive	11
CAL fails to deliver course material in sufficient detail/depth	11
It makes the learning process impersonal	9
Most CAL contains too many bugs	9
I am indifferent to it	4
It is a distraction	1
It threatens my job security.	1
It has no role to play	0

Current views

The eighty-two respondents expressed a total of five hundred and twelve opinions, both pedagogical and operational, on CAL material use. In such an exercise it can be argued that the tendency is for responses to come from enthusiasts but, notwithstanding these issues of bias within the sample of returned questionnaires, it is significant that only one in six views was negative. There was no obvious polarisation within the responses and most respondents returned a mixture of positive and negative opinions. The questionnaire contained a list of twenty-two different opinions, in no particular order, from which respondents could select as many as were acceptable. In Table 1, categories for the opinions presented include positive, negative or neutral ranked in order of popularity.

There was overwhelming support for the suggestion that CAL material 'aids the learning process' (84%) together with substantial support for the idea that CAL 'enables the sharing of materials' (65%) and that it 'promotes learning independence' (63%). Such opinions are consistent with the widely held belief that CAL material can enhance the quality of education delivered. It is also clear,

however, that the respondents were not so supportive of a once popular opinion that there can be significant savings in staff time through CAL use [7, 8]. Only one in three respondents believed they were 'more productive' as a result while the second most common negative opinion expressed concern about 'the time to get to grips with such packages'. These response rates are extremely similar to those found in the HEFCE survey of all TLTP materials [9]. One notable exception was that the engineers from the EASEIT-Eng survey were three times more likely to cite assistance in dealing with student numbers as a benefit when compared to the TLTP material users from all disciplines.

The major concern appears to be that CAL packages 'written by others do not meet [the] needs' of academic tutors who have reservations about how 'well-structured [and] comprehensive' they are. The concern does not seem to reflect the quality of material available or the presence of too many bugs, so there may be an element of the infamous 'not-invented-here' syndrome in this, but it remains an important issue. Nonetheless, almost a half of the respondents believe CAL use 'is inevitable' and/or that 'students expect it' and trends in schools and society generally are only likely to increase this figure. A survey of first year chemistry undergraduates at Liverpool University [10] found that regular computer use during the final year at school had almost doubled between 1996 and 1999, while computer ownership had more than doubled during the same period.

There was virtually no support for negative opinions at the extreme end of the scale. Even though one in five respondents were apparently using no CAL material, there was no support at all for CAL having 'no role to play' while just one respondent felt a perceived '[threat to] job security'. Only two respondents had no positive view to express; one was not directly involved in teaching and the other declared only a lack of 'time to get to grips with [CAL]'. The emerging picture from the survey appears to be one of a widespread but not particularly large community of realistic enthusiasts with a clear view of what the benefits of CAL use will and will not be.

Packages in use

Sixty-four of the respondents reported one hundred and twenty-seven (127) instances of use and the range of software quoted indicated considerable diversity in the interpretation of the phrase 'CAL material'. For the purposes of further analysis the following list of the software reported in use divides naturally into six categories according to their origin or principal use:

1. TLTP material.
2. Commercial CAL material.
3. In-house CAL material.
4. Commercial shells such as Question Mark, First Class and WebCT.
5. Office software such as the Microsoft Office suite.
6. Engineers' tools such as AutoCad and MATLAB.

It was not always straightforward to place software into just one of the categories and the distinction between engineers' tools and commercial CAL material was sometimes particularly difficult. In addition, software categorised as commercial shells or office software might well have been placed into the in-house CAL category but they have been given their own categories in line with the specific responses given in the questionnaire returns. Despite these issues, the trends emerging are noteworthy.

There were thirty-nine reported instances of use of TLTP materials encompassing twelve different TLTP developed products. The apparently most popular TLTP packages were EDEC (electronic design) and Mathwise (an integrated learning environment for teaching undergraduate mathematics), reported in use at six different institutions. Also popular were CALGroup (topics in Electrical, Electronic, Manufacturing and Mechanical Engineering) and GEOCAL/GEOtechniCAL (Ground Engineering), reported from five different institutions, and COMPACT (concrete technology), reported from 4 different institutions. In another HEFCE survey of the use of all TLTP materials [9], CALGroup and Mathwise were the two packages of most direct interest to engineers appearing in the list of packages most frequently reported in use, consistent with the sample in the EASEIT-Eng survey.

Curiously, institutions indicating use of a particular package were not in most cases involved in the original project consortium. This is noteworthy because it suggests that reservations about the suitability of material developed by others—the so-called 'not-invented-here' syndrome—are not holding back uptake within the community. It also raises the obvious question that the survey did not answer but on which subject a recent HEFCE survey [7] commented, 'In some cases little use appears to have been made of materials even in the institutions in which they were designed'. If this suggestion is unfounded and the original developers of TLTP material are using their packages then it raises a further question about why they did not respond to the questionnaire.

Use of commercial CAL material showed much less coherence with thirty-three reported instances encompassing twenty-seven different packages. Only Crocodile Clips (simulator to experiment with electricity, mechanics and sound), Electronics Workbench (design and verification of electronic circuits), CALMAT (mathematics tutorial system) and RC-CAL (from the Reinforced Concrete Council) were reported in use at more than one institution. Two factors might create this less coherent pattern of use: there is a very large

Table 2a. In what part of the curriculum is the package used? (Modes of use as % of instances reported in each software category).

	Total (all categories)	TLTP material (N = 39)	Commercial CAL (N = 33)	In-house CAL (N = 17)	Commercial shells (N = 11)	Office software (N = 16)	Engineers' tools (N = 11)
Coursework	57	49	61	47	55	50	100
Tutorials	54	69	48	53	36	50	36
Practicals	37	41	42	35	0	25	64
Lectures	32	18	27	29	27	75	45
Remedial	31	54	33	29	9	13	0
Distance/open	19	13	18	29	36	19	9
Group Work	17	5	21	12	36	19	36
Administration	8	3	3	6	9	38	0

number of commercial CAL packages available while TLTP materials are much fewer in number and free or low cost.

Fourteen different institutions reported seventeen instances of use of in-house CAL material. In the office software category, there were sixteen reported instances at thirteen different institutions, which is perhaps simply a reflection of the general popularity of such software. There were also eleven reported instances of use of commercial shells from nine different institutions. These three categories require academics to input their own content and classification in most cases might be as 'in-house' prepared material. It is, therefore, noteworthy that such an approach appears so popular in comparison with use of pre-prepared material in the commercial CAL and TLTP material categories given the excessive time involved in preparation. There were eleven reported uses of engineers' tools, clearly the result of the interpretation of the phrase 'CAL material' and not a genuine reflection of the use of software such as AutoCAD that was popular in this category.

Modes of use

Where specifically declared, CAL material use appears to be predominantly in Years 1 and 2 of degree programmes (eighty and fifty-five instances respectively) but use does prevail into Years 3/4 (thirty two instances) and even at postgraduate level (ten instances). These overall figures are very consistent with the usage reported in the HEFCE survey [9] of the use of TLTP material in all disciplines. Each respondent estimates that there are approximately two hundred students engaged in the use of CAL material, equating to more than 10000 students exposed to some form of CAL material just from the respondents to this questionnaire. According to UCAS (Universities and Colleges Admissions Service) statistics, around 20000 students are accepted onto UK engineering degree programmes each year so, to give an impression of the scale of uptake, it is estimated that in the region of one in every four first year students will use some CAL material.

Table 2a summarises the survey data examining the parts of the curriculum using software. The table shows the number, N, of reported instances of use in each category of software (TLTP material, commercial CAL, etc.), and within each category, the number of citations of a particular type of use (coursework, tutorial, etc.) expressed as a percentage of N. The category allowed respondents to tick as many options as seemed appropriate. The table also shows total figures all using reported instances used to rank the modes of use in order of overall popularity for all software categories.

Uses in coursework and for tutorials head the table at an overall rate in excess of one in two reported instances. Uses in practicals, lectures and for remedial work averaged about one in three of the instances while distance/open learning and group work were reported in less than one in five instances. The survey of C&IT uses in HE in all disciplines [7] indicated figures of around one in three for distance delivery and one in six for remedial work. The survey of the use of TLTP materials in all disciplines [9] reported a similar emphasis on use on-campus within 'traditional' courses rather than distance use. The office software category dominates the infrequent administration use.

Authors and publishers of CAL materials rarely seem to use promotional literature to recommend a particular mode of use for their software but the questionnaire responses indicate the emergence of quite a clear pattern of use. From the TLTP material uses reported there was a heavy bias in favour of tutorial use (69% and the highest of any software category) rather than lecture use (18% and the lowest of any software category). For commercial CAL material (48% and 27%), in-house CAL (53% and 29%) and commercial shells (36% and 27%), the pattern of use is similar but much less extreme. In contrast, the survey shows office software and, perhaps surprisingly, engineers' tools to be in more frequent use for lectures than tutorials. The highest reported use for remedial work was also the TLTP materials (54%), significantly higher than the level reported for either commercial CAL material (33%) or in-house CAL (29%). The authors are aware of a quite widely held perception that much TLTP material targets a low academic level and this might explain this pattern of use. The majority of respondents reporting use of TLTP materials for remedial work, however, also reported use in

Table 2b. In what part of the curriculum is the package used? (Modes of use as % of instances reported in groups categorised by student attitudes).

	Total (all categories) (N = 127)	'Happy' Group (N = 91)	'Neutral/unhappy' Group (N = 27)
Coursework	57	66	30
Tutorials	54	53	59
Practicals	37	42	22
Lectures	32	37	19
Remedial	31	31	30
Distance/open	19	21	15
Group Work	17	18	11
Administration	8	9	0

tutorials during Year 1 and in some cases Year 2, suggesting useful content across a range of levels. The greater investment of time and/or funds required to integrate commercial CAL or in-house CAL material might also be an influence on this aspect of the pattern of use.

Coursework use was a consistently popular application in all software categories, especially and understandably in the engineers' tools category (100%) as well as significantly in the commercial CAL category (61%). At around the two in five level, use in practicals was similarly likely in the TLTP material, commercial CAL and in-house CAL categories. Within the engineers' tools category, mathematics software was responsible for the high reported use for practicals (64%). Uses for distance/open delivery were most likely in the commercial shells category (36%) and for in–house CAL (29%) but this mode of use was not generally popular. Computer Aided Design packages made the engineers' tools category appear popular for group work (36%) with commercial shells equally popular (36%) probably as the result of communication facilities available within some of the shells in this category. Use of TLTP material for group work was especially infrequent (5%) and this pattern applies for TLTP materials in all disciplines [8, 9].

The questionnaire analysis presented in this paper makes comparisons between the reported instances (from all software categories) where tutors reported that their students were 'happy' with CAL material use and those where tutors reported that their students were either 'neutral' or 'not happy' with CAL material use. (The majority in this category checked 'neutral' with only three checking 'unhappy'.) The purpose of including this group is to investigate how exposure to patterns of software use might affect student opinions. If a particular mode of use does not affect satisfaction then the percentage of instances reported should be similar in the 'Happy' group and the 'Neutral/unhappy' group but a significant difference suggests an influence. (In nine instances there was no response to this question.)

Table 2b shows the first of these comparisons. It indicates much lower use of software for coursework, especially, as well as practicals and lectures in the 'neutral/unhappy' group compared to the 'happy' group, suggesting a link between these modes of use and student satisfaction.

Tables 3a,b summarise the survey data examining software use in different parts of the curriculum. The structure of these tables is broadly similar to Tables 2a,b and the tables list the parts of the curriculum in order of overall popularity. Again, the survey allowed respondents to tick as many options as seemed appropriate.

Overall, use as an additional resource was the most popular response, occurring in almost two out of every three cases and slightly over three times more likely than use as a replacement resource. The frequency of time-tabled use is two-thirds that for use as an additional resource indicating the balance between supported and unsupported use. Use as a replacement resource appears relatively unpopular both nationally and across disciplines [7]. Uses in assessed or non-assessed circumstances were equally popular. A sector-wide survey [6], focusing on Computer Assisted Assessment (CAA) and conducted at a similar time to this survey, found a similar pattern of use in which, of those reporting involvement in CAA, there was a 2:3 ratio between assessed (summative) use and non-assessed (formative, self-assessment or diagnostic) use. Use for assessment does not imply use under examination conditions, which was very infrequent.

As an additional resource, uses of TLTP material (79%) and in-house CAL (76%) both exceeded the total figure as they did for use as a replacement resource (36% and 24%, respectively). The popularity of commercial CAL, commercial shells, office software and engineers' tools as a replacement resource was low. Use of software in the Engineers' tools category (73%) was most likely in a timetabled session with TLTP material, commercial CAL and office software all around the 40-50% mark. Use of in-house CAL (29%) and, particularly, commercial shells (9%) appeared much more likely outside time-tabled sessions. Levels of use for non-assessed work were similar for TLTP material, commercial CAL and engineers' tools as they were for assessed work but at a generally lower level. The commercial shells category, which included software such as Question Mark, was interestingly the most popular software category for non-assessed work and only the

Table 3a. How do you use the package? (Modes of use as % of instances reported in each software category).

	Total (all categories)	TLTP material (N = 39)	Commercial CAL (N = 33)	In-house CAL (N = 17)	Commercial shells (N = 11)	Office software (N = 16)	Engineers' tools (N = 11)
Additional Resource	61	79	52	76	36	38	55
Time-tabled	41	41	39	29	9	56	73
Non-assessed	37	44	36	24	55	19	45
Assessed	30	33	36	18	27	19	36
Replacement resource	19	36	9	24	9	6	9
Exam conditions	3	0	9	0	18	6	0

Table 3b. How do you use the package? (Modes of use as % of instances reported in groups categorised by student attitudes).

	Total (all categories) (N = 127)	'Happy' Group (N = 91)	'Neutral/unhappy' Group (N = 27)
Additional Resource	61	55	74
Time-tabled	41	52	11
Non-assessed	37	30	59
Assessed	30	37	7
Replacement resource	19	24	7
Exam conditions	3	3	0

fourth most popular category for assessed work suggesting measurably greater emphasis on use for entirely formative purposes. The particularly low figure for use in timetabled sessions (9%) suggests furthermore that students do this in their own time. Table 3b shows significant variations between the responses from the 'Happy' group and the 'Neutral/unhappy' Group. The most significant variances came in the figures for use in timetabled sessions (38% lower in the 'Neutral/unhappy' Group), under assessed conditions (29% lower in the 'Neutral/unhappy' Group) and under non-assessed conditions (28% higher in the 'Neutral/unhappy' Group). These figures reinforce anecdotal opinions that student motivation to engage in activities not contributing directly to final marks is low and that timetabled use is key to establishing engagement with the CAL material. A combination of use as an additional resource, non-assessed use and not time-tabled use was particularly common within individual instances from the 'Neutral/unhappy' Group, suggesting substantial, unsupported use amongst this group.

Tables 4a,b summarise the survey data examining interactivity incorporated in the CAL material. Interest in this part of the survey was not with routine interactions such as data entry or hypertext links but with integrated simulations or on-line communication capabilities. The structure of this table is similar to previous tables with the types of interactivity listed in order of overall popularity. Again, the survey allowed respondents to tick as many options as seemed appropriate.

Overall, the most common response was that there was none of the types of interactivity listed (35%) but where inclusion of interactivity occurred, it was likely to be either simulations (30%) or e-mail (18%). In TLTP material, commercial CAL and in-house CAL, it appears equally likely that a user will find none of the interactions listed. In-house CAL and commercial shells were most likely to incorporate e-mail capability, bulletin boards or a chat forum suggesting that these communication features are a particular attraction of software in these categories. WebCT and First Class are the pieces of software responsible for creating such a strong impression in the commercial shells category and they may also have been responsible for the figures within the in-house CAL category. Except for e-mail, such features rarely appear in the other software categories. There may have been some misinterpretation by the respondents here since the authors of this paper are not aware of e-mail facility within the TLTP material cited. It might be that e-mail is used alongside the CAL packages rather than as an integrated part of it.

There are again some substantial differences between the responses from the 'Happy' group and the 'Neutral/unhappy' Group. The 'Neutral/unhappy' Group were more likely to have used software without such interactions, recording a figure 29% higher in the 'no interactions' category and 33% lower in the simulations category, emphasising the importance of making learning experiences as active as possible.

Student attitudes and support available

The final section of the questionnaire explored briefly the relationship between students' attitudes towards the software used for teaching, the level of academic support available to them and the type of technical support available to their academic tutors. From sixty-five responses, forty-six reported students to be happy, sixteen were neutral and three were unhappy. Only five cases were The

Table 4a. Are any interactions included? (Types of interactivity as % of instances reported in each software category).

	Total (all categories	TLTP material (N = 39)	Commercial CAL (N = 33)	In-house CAL (N = 17)	Commercial shells (N = 11)	Office software (N = 16)	Engineers' tools (N = 11)
None	35	36	36	29	18	31	55
Simulations	30	41	36	29	9	6	27
e-mail	18	15	18	24	36	19	0
Bulletin boards	8	0	9	12	36	6	0
Department notice boards	7	5	6	6	18	13	0
Live chat forum	6	0	0	18	36	6	0
Video conf.	2	0	0	0	9	6	0

Table 4b. Are any interactions included? (Types of interactivity as % of instances reported in groups categorised by student attitudes).

	Total (all categories) (N = 127)	'Happy' Group (N = 91)	'Neutral/unhappy' Group (N = 27)
None	35	27	56
Simulations	30	40	7
e-mail	18	16	19
Bulletin boards	8	8	7
Department notice boards	7	5	11
Live chat forum	6	4	11
Video conference	2	0	7

'Happy' Group described as receiving more support than in conventional teaching. In thirty cases, students received the same level of support as in conventional teaching but nine of these cases now described the support as 'specialised'. There were ten instances where students received less support. There were no obvious differences in these trends between this 'Happy' group and the 'Neutral/unhappy' Group except a suggestion that the 'Neutral/unhappy' Group were less likely to encounter any specialised help. Examining the technical support available for the academic, 78% of the tutors with 'happy' students felt they had adequate technical support while 63% of the tutors with 'Neutral/unhappy' students felt the same. Support for the tutor may therefore be a more important issue than direct support for the students but the differences are not great.

ANALYSIS OF RESPONSES FROM LEARNING TECHNOLOGY CO-ORDINATORS

Several responses to the academic questionnaire included in the preceding analysis appear to have come from Learning Technology Co-ordinators (LTCs). Learning Technology Co-ordinators received a specific and appropriately modified, version of the academic questionnaire. From six responses returned and a summary of the key points, which must be seen in the context of the low number of returns, follows.

The current views of the LTCs based variously at departmental, faculty or institutional level, were broadly in line with those of the academics. Agreement occurred on the three most popular positive responses:

- 'It aids the learning process'.
- 'It enables sharing of teaching materials'.
- 'It promotes learning independence'.

Agreement also occurred on the three least popular negative responses:

- 'It is a distraction'.
- 'It threatens my/academics' job security'.
- 'It has no role to play'.

None of the LTCs felt CAL use was 'inevitable' or that 'students expect it' whereas close to half of the academics ticked one or both of these opinions. The LTCs were more critical than the academics of openly available CAL material but they were very positive, perhaps predictably, about their own in-house CAL. At the same time they expressed the usual concerns about in-house CAL that can be time consuming to prepare, expensive to maintain and sometimes ill-conceived. LTCs were also less content with the level of institutional support.

COMPARISON WITH AUSTRALIAN HIGHER EDUCATION

A project partner also conducted the survey of CAL use in Australia, albeit on a smaller scale than for the UK, to make comparisons with a similar, English-speaking HE market. Distribution of questionnaires took place in three Australian universities believed to form a representative group within Australian Higher Education Institutions. Eleven academic questionnaires and three LTC

Table 5. Comparison of the views of UK and Australian academics.

	UK (%)	Australia (%)
Agreement on pedagogical reasons for use		
It aids the learning process	84	82
It enables sharing of teaching materials	65	64
It promotes learning independence	63	73
It addresses the problem of mixed abilities	41	36
Australian academics are more critical of existing CAL material		
CAL offers quality software simulations and courseware	54	36
CAL delivers well-structured, comprehensive teaching material	30	18
CAL packages produced by others do not meet with my needs	26	27
It changes too quickly	11	36
CAL fails to deliver course material in sufficient detail/depth	11	18
Most CAL contains too many bugs	9	18
Australian academics strongly support operational reasons for use		
It supports the management of my teaching materials	48	91
It is a way of surviving high student staff ratios	44	64
It makes me more productive	32	64

questionnaires were returned together with additional breakdowns of the CAL packages used providing details from around 75% of the Engineering Departments within the three universities involved in the survey.

Convenient computer access, especially PC, and Internet access is as routine in Australia as it is in the UK and levels of support available for learning technology activity were broadly similar. As far as pedagogical aspects, such as the influence on the learning process and the promotion of learning independence, are concerned, the Australian academics' views were remarkably similar to those expressed in the UK but the Australians were measurably more critical of existing CAL material. There was markedly greater support for the notion of an increase in productivity, consistent with the feeling of enhanced management of teaching materials. The Australian survey cited coping with high staff student ratios more frequently but it also highlighted the concern that the learning process was too impersonal. The average staff—student ratio on Australian engineering degree programmes is around 15, having increased by 50% in the last 15 years [11], a situation not dissimilar to that in the UK. The principal similarities and differences are summarised in Table 5.

Use of CAL material was more likely in Years 3 and 4 of the Australian degree programmes. The same broad interpretation of the term 'CAL material' was apparent in the Australian data with a range of software packages in the office software and engineers' tools categories detailed in the returns. Discounting the software in these categories, perhaps the most striking feature of the CAL material used was the almost complete absence of any of the packages used in the UK from the information compiled. None of the TLTP materials had penetrated the Australian market and Question Mark, a popular shell in the UK, typified this trend in receiving just one mention. Australian HE has benefited from its own initiatives such as the Higher Education Innovation Programme and the National Teaching Development Grants. In the US, the National Engineering Education Delivery System (NEEDS) [12], with funding from the National Science Foundation, offers web access to a digital library of learning resources for engineering education. Searching the NEEDS database for information on TLTP materials yields a similar result.

CAL material use for tutorial work accounted for over 80% of cases, a much higher level than encountered in the UK while coursework, the most popular part of the curriculum for use in the UK was significantly less popular in Australia (25%). Uses for remedial work were much lower in Australia, consistent with greater use in later years of degree programmes, while distance delivery was more popular, just exceeding 30% of reported uses.

Use of CAL materials as additional resources are even more likely in Australia, yet their use as replacement resources is even less likely, but the most remarkable difference is in the comparison between assessed and non-assessed use. Non-assessed use is significantly less likely, around 10% in Australia compared to around 40% in the UK, while assessed use shows the opposite trend, around 90% in Australia compared to only 30% in the UK. Use under examination conditions is marginally more popular in Australia but still infrequent.

Commercial inclusion of overall interactivity into CAL material through communication tools or simulations was about 10% less likely than in the UK but simulations specifically were 10% more likely. Reports also indicated that there was a slightly higher level of use of e-mail and bulletin boards.

CONCLUSIONS

The EASEIT-Eng survey of CAL activity in UK engineering degree programmes has shown a pattern of widespread but far from coherent or

prevalent use. The TLTP materials show most instances of use of any of the types of software as well as the most coherent pattern of usage. Reports indicated that commercial CAL material was in use slightly less frequently than TLTP material. Unlike textbooks, tutors are a more likely target for CAL material sales than students, suggesting that CAL materials generally are not currently a commercially attractive prospect. This cannot be in the interests of developing the best possible software and maintaining it thereafter. Some respondents described the software they use as in-house CAL while others reported use of commercial shells and office software. Such uses all require input of technical content by the academic or their agent and aggregation of these categories is of interest. Aggregating these responses indicates a level of usage comparable with the aggregated use of commercial CAL and TLTP materials, showing how popular it remains for academics to prepare their own material in the same way as is usual, for example, for traditional lecture material.

Engineering academics appear convinced of the pedagogical benefits but less so that the right material is already available for them and that there will be any time-saving associated with its use. CAL material is popular in the early years of engineering degree programmes, especially for delivery of coursework and for tutorial help, usually as an additional resource rather than as a replacement. Use for non-assessed purposes is slightly more common than for assessed purposes but use under traditional examination conditions is rare. Much material lacks interactivity, for example communication or simulation capabilities, and this appears to be an issue for maintaining student happiness and, therefore, motivation to use the material. Use in time-tabled sessions and the incentive of assessing the work completed also both appear important in maintaining positive attitudes amongst the student users.

Australian engineering academics agreed broadly with the UK assessment of the pedagogical benefits but they were much more supportive of the idea that there were operational benefits of CAL use. An important finding in the comparison between use in the UK and Australia was how few CAL packages were in use in both HE markets. This situation is apparently similar in the US, surely suggesting a large degree of duplication in the development of CAL materials especially in the government funded initiatives in each country. At the same time, this might indicate the availability of a wealth of materials for exploitation.

Acknowledgements—The authors wish to acknowledge the support of HEFCE and DHFETE who fund the EASEIT-Eng project through the third phase of TLTP. The authors also wish to acknowledge the contributions made by all the partners in the EASEIT-Eng project, especially Tom Page and Chris Austin at the University of Hertfordshire for their initial analysis of the questionnaire data and Professor Bill Upfold at the University of Wollongong who organised collection of the Australian data. Finally, the authors wish to thank all the respondents to the questionnaires distributed.

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