

# A SURVEY INTO THE EFFECTIVENESS OF WEB-BASED TEACHING OF BUILDING DESIGN COST MANAGEMENT

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The design and construction of building projects is a complex and demanding process, involving a variety of different disciplines including architecture, quantity surveying, engineering and construction management. Their common objective is to deliver, on behalf of clients commissioning construction work, buildings of the right quality at the right price and within the right time scale. A related imperative is the need for improvements in communications between all the parties involved in the design and construction process. This will ensure the achievement of the overall objective by a more effective information management system, underpinned by information technology, to overcome the many criticisms of the industry, in terms of delivering projects, which are often late, over budget and of poor quality. This paper evaluates the use of a web site, that has been developed by the authors, to accompany a text book. Together they set out to explain the process of design cost management, by reference to a simulated project, to demonstrate its application. The paper utilizes a questionnaire methodology, to gather data on the effectiveness of the approach in developing knowledge and skills in this important subject area, from an interdisciplinary group of final level undergraduate students, studying quantity surveying and construction management programmes. The paper reflects upon the design and structure of the web site to facilitate learning in applied construction economics.

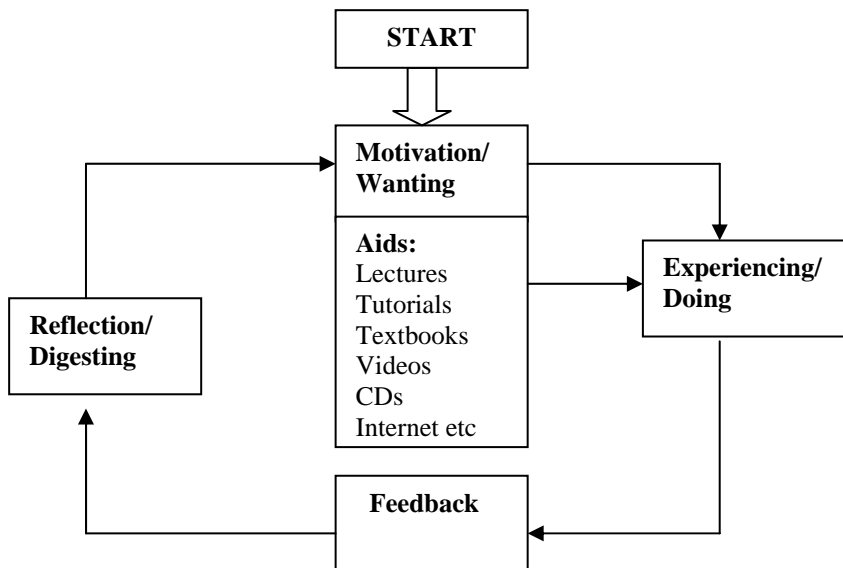
Keywords: Design cost management, information technology, learning survey, web based teaching.

## INTRODUCTION

The development of the web site, described in this paper, as an aid to the teaching of design cost management, arose as a result of the preparation of a text book (Jaggar et al 2002) addressing this important subject area. The text book was written with the aim of achieving the following three objectives:

- Explaining the principles of building design cost management as a necessary part of the design process
- Demonstrating its applications
- Discussing its limitations and possible future changes and developments.

There are numerous well- prepared textbooks (Ashworth A.1988, Ferry D J, Brandon P S and Ferry J D 1999, Flanagan and Tate B 1997, Morton R and Jaggar D M 1995), which, in various ways, address the issues identified above. During the preparation of the book, considerable thought was given as to how the book might be made more effective as a teaching and learning aid, especially as the subject of design cost



**Figure 1:** The process of experiential Learning adapted from Race (1989)

management is perhaps best understood and implemented through the use of experiential learning. There was a need to simulate, in some way, how design cost management is applied as a part of the design process. This view was supported by research evidence which suggests that people learn best by experiencing and reflecting on tasks, rather than, merely, by abstract conceptualization; in effect "learning by doing" (Race 1989). An essential part of such a learning strategy is that of self-motivation by the learner. Such self-motivation can be encouraged by the use of interesting and supportive learning aids such as multi-media applications, in addition to normal pedagogic techniques, such as lectures, tutorials and seminars, supported by written information concerned with the subject area under consideration. Figure 1 below illustrates the experiential learning process.

Additionally, it was felt that, if experiential learning could be simulated within a time frame driven by the learner, rather than the teacher, the following major benefit could be achieved, which is of particular help to part-time students and those studying by distance learning: To enable the students to manage their own learning experience rather than being controlled by the explanation and pace of the educator, thus enabling the student rather than controlling the student. An additional problem, associated with textbooks on design cost management, is how to handle the large amounts of data concerned with quantitative, qualitative and cost information, in the various forms and arrangements in which it is needed, to be able to fully explain and demonstrate the process of design cost management. A further requisite in the explanation of the design cost management process is the ability to inform and demonstrate to the learner the dynamic nature of the process, as the design develops in maturity from inception through to completion. The authors also wished to incorporate real data, some of which was available from the Building Cost Information Service (BCIS) (BCIS on line 1998) which is the custodian of information concerned with various building projects undertaken within the United Kingdom. This data has been analysed within a consistent and agreed format and is supplemented by ancillary information, such as various indices reflecting changes in time, cost and price, together with general construction related information commenting on economic trends, changes in construction law etc.. The reason for linking to the BCIS in this way was twofold: To show the use of the BCIS as an essential nationally available tool for use in design cost management. To make use of real data, thus giving a sense of realism to the

explanation and demonstration of the design cost management process. Once permission was gained to use data from the BCIS, it was felt that the best way to create an experiential learning environment was to describe and demonstrate the process of design cost management by means of a real life building project. A project, which was ideal for the purpose, was obtained from a Merseyside based chartered quantity surveying practice. The authors then looked for a mechanism to support the experiential learning strategy. Initially the notion of a compact disc containing the relevant data, the building project, together with the accompanying cost models, reflecting the various stages of maturity during the development of the design process, was considered, to accompany the book. However the final solution was, rather, to develop a dedicated web site, which was considered as being the most appropriate tool to enable the learner, by means of experiential learning, to gain the following benefits: Gain an understanding of the benefits of web supported information technology, as part of the developing e-commerce culture in commerce generally, and in design cost management specifically Provide a dynamic modelling facility, allowing the application of rapid and easily accomplished iterations, as a necessary process in seeking optimal solutions in complex problem solving, as in design cost management Encourage a better appreciation of the role and purpose of the BCIS in the provision and management of financial information. Provide a more readable and interactive text, using the supporting data contained in the web site to demonstrate and support the concepts described and developed therein. This paper goes on to explain the learners' experiences of the web-site as an aid to experiential learning. The results and the analysis of these experiences are presented later in the paper but, before discussing these outcomes, it is necessary to say a little about the design and content of the web site.

## **DEVELOPMENT OF THE WEB SITE**

The site works in two complementary ways:

- Demonstrating the points which are highlighted predominately in chapters 9,10 and 11 of the text. This is achieved by means of a computer symbol in the text that, through the web site home page, invites the reader to see further information that additionally develops or amplifies the point being made. Typical examples are BCIS cost analyses, average building prices and indices, together with drawings, specifications, and cost models at various levels of detail, to demonstrate the process of building design cost management along with its information needs.
- By means of the case study, the real life building project, recently completed on Merseyside. Again access is gained through the web site home page. This feature allows the user to trace the building design cost management process for an Electronics Factory together with having access to the supporting information obtained from the BCIS and other members of the design team such as the architect and services engineer . The user is able to see the authors' default solutions against the various stages of the RIBA Plan of Work (1998) and also override these default solutions by inserting his own particular cost, specification and size parameters.

The site thus provides the background information to complement the theoretical information contained in the text, both generally and specifically, through the case study, and has the additional useful benefit of having a dynamic quality whereby the user can develop his/her own cost models for the same, or a similar case study.

In addition to the features highlighted above, the site, through the home page, also contains information about the authors, has information for lecturers in the form of power point presentations on building design cost management and has a number of useful links to other relevant sites, such as the RICS, the BCIS, the RIBA, Blackwell Publishing and others. The web-site domain name, [www.bdc.m.co.uk](http://www.bdc.m.co.uk) (2002), was selected to reflect UK practice, to be easy to remember and to provide a link with the textbook. It has been registered with a domain name registration service, Nominet and an internet service provider was chosen that gave fast access, few restrictions on space and was reliable. It is anticipated that the use of the web-based approach will facilitate the following developments:

#### **Increase the student base**

The site aims to reflect international factors and allow for differing nationalities to compare and contrast the professional practice of different countries.

#### **Increased learner accessibility**

The site allows unlimited access to design cost information which is only available from the BCIS under a license agreement which not all academic institutions are willing to invest in and access is limited to single user participation. This site makes no charge for its use and can be accessed any time anywhere by any number of users.

#### **Ease of updating**

A particular benefit of the site, unlike a textbook, is that the data contained within it can easily and quickly be updated. It is anticipated that the cost analyses, tender price data and average cost data will be updated annually to ensure the data remains contemporary.

#### **Increased learner effectiveness**

The approach to the design and structure of the site allows for a flexible approach that can be adopted by the learner and is essentially making use of experiential learning which, as discussed above, is a particularly effective means of teaching and learning.

#### **Provides a central point for learning resources information that includes**

- Cost Information from the BCIS
- Average construction cost information, a selection of group and detailed elemental cost analyses, tender price and cost indices information and locational price information.
- Design information relating to a real life example including:
  - Client brief, sketch plans, detailed design drawings, specification, borehole reports, outline and detailed cost models in the form of cost plans
- Teaching resources:
  - Power Point slides of a lecture programme that accompanies the text, which further explains and develops the design cost management process.

## **WEB SITE DESIGN**

### **Generally:**

The authors recognized that the web site should reflect the learner's need for access to design and cost information that would be typically available at various stages of the building design process. One of the criteria for the choice of the case study was the availability of the full range of design information from client brief through sketch plans to detailed design. The choice of an appropriate template was selected from a range as developed by Jolliffe et al (2001) that included:

Structured: The learner works through the information in a manner dictated by the designer

Linear: whereby the presentation-learning template is designed to reflect a linear nature

Adaptive-i.e. a template that reflects the material based on information about the learner's knowledge and approach.

A linear approach to allow the user to use the site as stand-alone facility was adopted. To facilitate this the RIBA plan of works (1998) was chosen to reflect the main processes of the design development. Accompanying each stage, through the RIBA plan of work, is textual information which aims to enable the user to understand the purpose and content of each of these various stages, as the design solution develops. This enables the user to understand the relevance of the information available at each of the various stages and thus encourages judgements to be made about its significance. The authors have also developed their own interactive spreadsheets which allow the users to access and reflect upon the cost models at appropriate points along the design development continuum. The interactive features were incorporated to allow the user to carry out scenario testing, by changing and inputting some of the variables.

### **CAPTURING OF INFORMATION:**

AO drawings were reduced and scanned into jpeg format, CAD format was considered, however rejected, as it was felt this might limit the usability of the site. Borehole reports and site layout plans and all other graphical information were imported into the pages.

### **WEB SITE SOFTWARE:**

The Macro media suite of programmes, Dream weaver and Fireworks, were used to develop the site. The use of Flash was avoided as it was felt that the speed of downloading was important to users with limited bandwidth.

## **METHODOLOGY**

A quantitative methodology was adopted as this stage of the research and aimed to collect data on attitudes on how the technology had supported leaning and preparation of assessments. This method was selected in favour of a more qualitative approach as it was felt that the data collected was less likely to be biased as the questionnaire contained no identifying information and was distributed and collected in a manner that made it impossible to match responses with individuals. The population for the investigation was a group of forty two final level construction management and

**Table 1** : Questionnaire returns

	Frequency	Percent	Valid Percent	Cumulative Percent
LJMU	30	75.0	75.0	75.0
LU	10	25.0	25.0	100.0
Total	40	100.0	100.0	

quantity surveying students studying a financial control module during semester one as part of their programme of study at Liverpool John Moores University and Liverpool University. The measuring instrument was distributed at the start of semester two 2003, after the students had a period of time to reflect on the approach adopted and also had received feedback on coursework and also module marks.

### Measuring instrument development

The web-based case study was used as the central vehicle for learning and respondents were required to complete a number of tasks that required access to web based materials such as cost and index information, development of cost models and the identification of savings by alteration to specifications. As the approach taken in supporting the teaching relied heavily upon the user's ability to utilize web technologies for access and manipulation of files, the use of spreadsheets and basic navigation and it was felt important to collect data on IT skill level. A number of questions were used with Likert scales that collected information on students self assessed skills before and after using the site. The Quantity Surveying students had studied a formal IT module prior to the final level and the authors considered that a useful comparison of IT skills between the two groups and the effect it may have had on the efficacy of the site would be useful. The Building Design Cost Management textbook was a recommended text to accompany the assessment tasks and although was not essential, it was felt that information on whether the text was used during the task completion, revision or when using the website would provide some useful information on student use of texts and web sites in supporting learning. The respondents' attitudes on how the BDCM website content and structure were perceived as supporting learning were collected via six point Likert scales. The web areas were subdivided into the case study, BCIS cost information, the PowerPoint slides, links to other sites and on how the text links were accessed. Respondents were also asked to reflect on the task driven approach, whether it helped structure their learning and also whether it influenced them on the use of the website. The website had been developed using relatively small files however it was felt important to collect information on the location of the users when accessing the site as this would have implications for future developments such as video and audio files. Two open questions were used to capture information on website improvements and how the approach to the assessment could be improved. The questionnaire was developed to collect nominal and ordinal data and was piloted and amendments made prior to it being distributed. It was three pages long and took approximately ten minutes to complete.

### Sample

A total of numbers of questionnaires were distributed to a sample size of 45, 40 were returned giving a return rate of 89 %. The questionnaire returns are given in Table 1.

The average age of the respondents was between 21-24, 8 respondents were over 25 years of age. 75% of the respondents were studying at LJMU

**Table 2:** Self assessed IT skills, 1=Excellent, 2=V.good , 3=good, 4=average,5=poor

ICT skill	Respondents average-Before	After
Spreadsheet skills	3.00	2.56
Web site navigation	2.83	2.78
File handling	2.88	2.97
Moving data between packages	3.21	3.06

**Table 3:** Website area and respondents opinion on utility

Web site area	Respondents average	% access
Brief	1.60	100
Design Information	1.60	100
PowerPoint slides	1.62	97.5
BCIS Indices	1.63	100
BCIS Analyses	1.70	100
Textbook links	1.78	92.5
Links to other sites	1.88	90

### IT skills and site use

Table 2 indicates the respondents self assessed IT skills.

Respondents self assessed IT skills were good or better in all the areas considered, a reported improvement was evidenced for three out of the four skill areas. Due to the sample size and the difficulties in relative nature of self reporting data, little significance can be given to the indicated improvements in IT skill however the responses demonstrated that IT skills were not reported as a limiting factor in usability of the website. A cross tabulation analysis of the data for the different groups indicated that the IT skills before and after the task completion were similar.

### USE OF TEXTBOOK AND WEBSITE

Respondents indicated their opinion on the utility of the site on a six point Likert scale(1= very useful, 2= Useful, 3=not useful, 4=Unhelpful, 5=very unhelpful and 6= did not access.) The results are shown in table 3 below.

The respondents ranked the brief and design information as having the greatest utility in completing the tasks. The textbook links were ranked 6<sup>th</sup> and supported conclusions drawn from observing the website in action in that it tended to be used to respond to specific tasks rather than supporting reflective learning. The links to the other sites was ranked 7<sup>th</sup> which indicates that the site was used for a specific purpose rather than as a portal to other areas.

### STRUCTURE OF THE SITE

Additional information on the design of the website and opinions on how the information presented supported the users learning activities was sought using a five point Likert scale (Strongly agree, Agree, Uncertain, Disagree and strongly disagree.

**Table 4:** Measures of agreement and web design issues

Design issue	SA	A	U	D	SD	No response
Website supported learning	17.5	65	12.5			5
Information was presented in a manageable format	10	67.5	15	2.5		5
Cost information was easy to manipulate	10	55	25	2.5		7.5
Design information was in a manageable format	12.5	55	22.5	2.5		7.5
Spreadsheet models demonstrated format of advice	17.5	60	15			7.5
Cost models demonstrated applicability of cost data	7.5	77.5	10			5
Cost models demonstrated the use of index adjustments	15	75	5			5
Sensitivity analysis using spreadsheets was carried out	2.5	45	27.5	17.5		5

**Table 5 indicating** respondents measure of agreement with statements concerning approach to learning and access of website. ( SA= strongly agree, U= uncertain, SD= strongly disagree, NR= non response)

	SA	A	U	D	SD	NR	Msr of agreement
Sequential tasks assisted in structuring learning	15	50	22.5	7.5		5	3.76
Wouldn't have accessed the site if not a prerequisite for task completion	12.5	47.5	17.5	17.5		5	3.57
Would access site in future	10	70	10	5		5	3.89
Gained a good knowledge of cost advice processes	20	60	12.5	2.5		5	4.03
Gained a good knowledge of types of cost information	20	70	2.5			7.5	4.18
Gained a good knowledge of how to use cost information	12.5	67.5	12.5	2.5		5	3.90
Completed responses outside tutorial time	22.5	60	5	5	2.5	5	4.0

The respondents agreed that the site supported their learning and although they didn't indicate the use of the spreadsheet models for sensitivity analysis they found this aspect of the site particularly useful. The cost analyses and design information format and manipulability were areas that respondents indicated their uncertainty with and this was also reflected in the responses to two open questions.

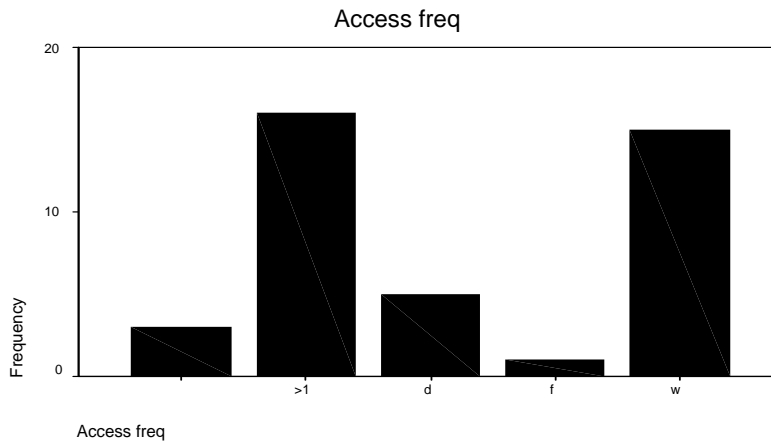
**The use of multi media approach to support learning**

The responses to questions on motivation to access the site and the respondents reflection on knowledge gained were gathered using a five point Likert scales and are given in Table 5.

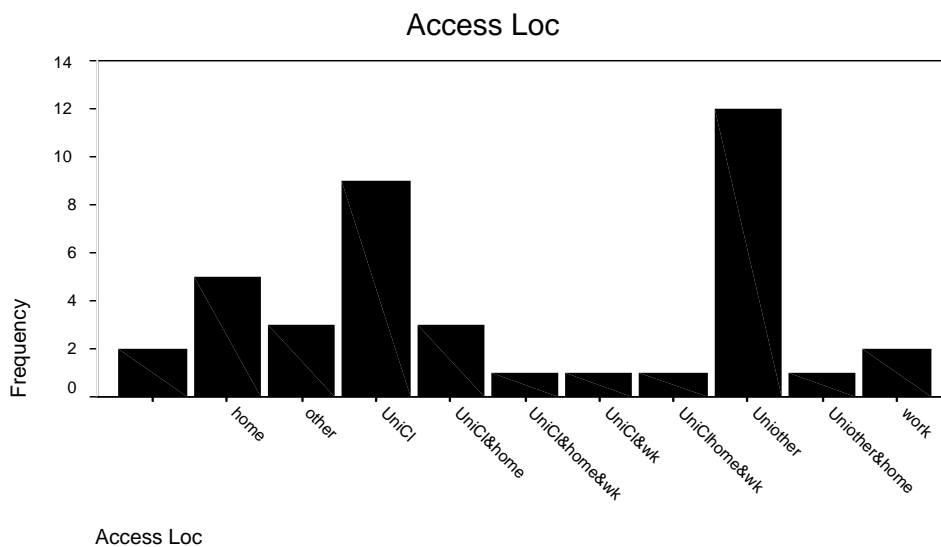
The respondents indicated that they were in general agreement with the statement that the tasks assisted their learning and that they would access the site in the future. Their responses indicated that they agreed that they had gained knowledge of the different types and use of cost information during the process of providing cost advice. They indicated that they mostly completed the responses to the tasks set outside of the timetabled tutorial sessions.

The respondents tended to access the site weekly or greater than once per week as indicated in the figure 1. This supported the authors' view that learning activities tended to take place at a time outside the timetabled sessions and at a time and place that was convenient to the user. The data gathered on access location is shown in figure 2 and indicated that the users tended to access the site via university facilities that were located in the other parts of the university.





**Figure 1:** Web site access frequency



**Figure 2 :** Bar chart indicating the range of locations of students accessing the site, (UniCl=Teaching location, Uni other= location in the university other than teaching environment)

## CONCLUSIONS

As the site is developed to date, it represents the commencement of the application of web based technology in this important discipline, which will, without doubt, improve, in terms of comprehensiveness and flexibility and thus usefulness, to the user. Evidence from the teaching and learning of building design cost management, using the text book and the site, at Liverpool John Moores University, has shown that it is a powerful aid to developing the students' understanding of its principles and application. The survey has indicated that users tend to access learning materials at a time and place that is convenient to them and that they tend to use high-speed machines. The survey indicated that the approach to encouraging learning through the use of structured tasks was successful in stimulating learners to access the website and that having developed an appreciation of its content were likely to access it in the future. One of the difficulties in developing a case study and associated tasks that support the approach was the provision of design information, the web site provided non scaleable jpeg images which were not considered as being very manipulable, the

alternative of “zoomable” pdf files doesn’t provide much improvement to this aspect and is an area that is being investigated. The textbook links were accessed however the users tended to access the site to provide support in responding to the tasks, the aim of providing a learning environment that encouraged reflection as well as demonstrated the application of theory has only been partially met. The development of the web site to encourage reflection during the process of developing design cost advice is an area for future consideration.

## **ACKNOWLEDGEMENTS**

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2.1 Basis of Total Cost Management Processes. 2.1.1 TCM Is Based on Process Management Principles. 2.1.2 The Basic TCM Process Model—Plan, Do, Check, and Assess (PDCA). 2.1.3 The Asset Life Cycle. Total Cost Management (TCM) is the effective application of professional and technical expertise to plan and control resources, costs, profitability and risk. Simply stated, TCM is a systematic approach to managing cost throughout the life cycle of any enterprise, program, facility, project, product or service. The TCM Framework is a representation of that “systematic approach”. However, optimal effectiveness of a sub-process requires that it be developed in the context of and relationship to associated sub-processes that share common strategies and objectives. The effectiveness of innovation is directly related to the total cost of the innovation project. The higher the efficiency, the more expensive the project is. Consider methods for estimating the value of an innovative company (project). 1. Discounted cash flow method (English Discounted cash flow , DCF ). At the same time, the valuation is performed using a cost approach or is based on the current value of the company's assets. Most often this method of evaluating an innovative company is applied to the "seed" stage. 4. Method of comparable assessments (evaluation by analogy). It is based on a comparison of several key indicators used in valuation of the company ( P/S, P/E , etc.), with indicators of similar organizations operating on the market. reliable cost estimates. The first part discusses general BIM usage by Quantity Surveyors and the second part examines the BIM capabilities especially in the use of software in assisting Quantity Surveyors to achieve more dependable results in their cost estimating practice. From the literature review, the BIM capabilities were synthesised into three broad categories according to their importance in estimating cost, including data visualisation, reliable database and data coordination. The results were then hypothesised to affect the reliability of cost estimates in quantity surveying practice... MATEC Web of Conferences 66, 00042 (2016). IBCC 2016. B. Cost-Efficiency and Cost-Effectiveness. In the economic literature, there is an important difference between cost-efficiency and cost-effectiveness. For our purposes here, cost-efficiency is defined as the provision of education at either less cost or more students at the same cost. Cost-effectiveness is defined as the provision of more or better learning at the same or lower cost. Put more simply, efficiency tends to emphasize more quantity while effectiveness includes an emphasis on greater quality. This study is based on survey research that collected information from participating higher education institutions. As this is one of the first attempts to assess faculty development for online teaching practices in a national sample, survey research is an appropriate approach.