Achieving Literacy in Sustainability: Shifting the Paradigm for Construction Management Education

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A thesis submitted in partial fulfilment of the requirements of Liverpool John Moores University for the degree of Doctor of Philosophy

April 2008

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Declaration

This is to certify that;

1. This thesis embodies the author's research

2. The originality (and contribution to knowledge) rests solely with the author

3. The work has not been used in any part to contribute to any other qualification

Signature of Candidate..

Date........11th April 2008.......................................

Acknowledgements

I would like to acknowledge the following people for specific help and support given during the research work and production of this thesis.

- Dr Rafid Alkhaddar my Director of Studies for his overall support.
- Dr Maureen Blackmore, second supervisor, for help with phase 1.
- Professor Mantz Yorke, second supervisor, for help with phase 2.
- Professor Marjan Sarshar, second supervisor for help with phase 3.
- David McLean Contractors for financial assistance during phases 1 and 2.
- Mike Riley for his continuous support of everything I do.
- My husband Steve for all the help he gave at home that made it possible for me to undertake a project of this nature.

I would also like to thank the following people who at some time during the duration of the study assisted by giving either help and/or support:

Dr Karima Saci, Rob Hughes, Linda Howes, Paul Murray, Dr Andy Ross, David Morley, Vince Kwasnica, and the construction management programme leaders in the UK and Australia.

This thesis is dedicated to my son Samuel. I have been undertaking this work for six of his seven years and now will have time to be a better mum.

List of Abbreviations

AIB	Australian Institute of Building
BA	Bachelor of Arts
BEng	Bachelor of Engineering
BOQ	Bill of Quantities
BRE	Building Research Establishment
BREEAM	Building Research Establishment Environmental Assessment Method
BS	British Standard
BSc	Bachelor of Science
BSIRIA	Building Services Research and Information Service
CIB	Construction Industry Board
CIBSE	Chartered Institute of Building Services Engineering
CIC	Construction Industry Council
CIOB	Chartered Institute of Building
CIRIA	Construction Industry Research and Information Association
CRISP	Construction Research and Innovation Strategy Panel
DEFRA	Department for Environment, Food and Rural Affairs
DETR	Department of Employment, Training & Rehabilitation
DFE	Department for Education
DfBERR	Department for Business Enterprise and Regulatory Reform
DfES	Department for Education and Skills
DTI	Department for Trade and Industry
EC	European Community
EMAS	Environmental Management and Audit System
EMS	Environmental Management System
ESD	Education for Sustainable Development
FHE	Further and Higher Education
FT	Full time
HE	Higher Education
HEA	Higher Education Academy
HEFCE	Higher Education Funding Council for England and Wales

List of Abbreviations continued......................

HEI	Higher Education Institution
HMG	Her Majesty's Government
ICE	Institution of Civil Engineers
ICLEI	International Council for Local Environmental Initiatives
IStructE	Institute of Structural Engineers
KPI	Key Performance Indicator
LA	Local Authority
LA21	Local Agenda 21
LJMU	Liverpool John Moores University
ODPM	Office of the Deputy Prime Minister
PDP	Personal Development Planning
PT	Part Time
QAA	Quality Assurance Agency
RAE	Research Assessment Exercise
RIBA	Royal Institution of British Architects
RICS	Royal Institution of Chartered Surveyors
RTPI	Royal Town Planning Institute
SPSS	Statistical Package for Social Sciences
SDE	Sustainable Development Education
SW	Sandwich
UK	United Kingdom

Abstract

Construction work and buildings have a major impact on the environment through site modification and the majority contribution to energy use worldwide. Therefore if changes are made to construction processes and the design of buildings, the potential for slowing down environmental degradation could be significant. There is a significant body of academics that believes the education of undergraduate construction students who will be the construction professionals of the future, is the key to making the changes required to industry practices to improve environmental performance.

This thesis identifies why initiatives aimed at improving undergraduate environmental knowledge and then attitudes have not been supported more fully by the HE sector, specifically within the construction management discipline. It also explores the use of educational frameworks developed by the relevant professional body in supporting the development of environmental knowledge in graduates.

The pedagogical research undertaken involved an extensive literature review and the gathering of data from UK universities and the UK construction industry. Additionally data was gathered from Australian universities in an attempt to identify aspects of good practice in curriculum design to promote literacy in sustainability.

The analysis of data led to the development of a model for curriculum design that can be used in conjunction with the professional body framework to promote literacy in sustainability. The validity of the model was evaluated using a simulation of the model in a small scale project and testing changes in student knowledge, attitudes and behaviour before and after undertaking the project.

A mixed model methodology was utilised in each phase that allowed for the use of a combination of qualitative and quantitative approaches to data collection and analysis at each stage of the work.

1.0 Introduction

1.1 Context, Overview and Background

Construction work and buildings have a major impact on the environment through site modification that reduces environmental wealth through resource consumption (CIB, 1999; Edwards, 1999; Langston and Dingk, 2001). In addition, as Webb (2000) states, we know that the built environment makes the majority contribution to energy use worldwide (50%), half of this is through the actual construction process and transportation and half through the life of the building. Therefore if changes are made to construction processes and the design of buildings, the potential for reducing and slowing down environmental degradation could be significant given the share of energy and natural resources they use.

The construction industry is the largest industry in the UK and turnover grew from £107bn in 2005 to £114bn in 2006. Total output is predicted to rise by 2.5% to 3% by 2009 which will mean that the actual turnover will be between £116.5bn and £117.5bn (Davis Langdon and Seah, 2007). Traditionally the elements of work classified as 'new build' accounts for approximately 50% of all work and work classified as 'refurbishment' for the other 50%. However, in 2006 new build work rose by 5% taking the total percentage to 55%. These figures are interesting to the research project for a number of reasons:

- Refurbishment work tends to be viewed as being more environmentally friendly, because there is more use of existing buildings and less use of new materials. Therefore the potential for increased environmental damage from construction work is reduced.
- As overall turnover continues to increase the potential impacts of construction work will increase.
- The trend towards more new build work and higher value contracts will increase the chance of choice of procurement being design and build. This means that more construction management students will progress to careers in contracting organisations that have specialist design and

build units. Therefore students will need to be fully cognisant of the principles of sustainable design in addition to sustainable construction.

This statement will be developed further in 2.2.1.

One way that the UK government can ensure that changes happen in construction practice, is through legislation which would involve penalties for non compliance. The government has implemented a number of significant legislative interventions to try to address these issues. A good example that is aimed at attempting to reduce energy use over the life of buildings is the revisions of Part L of the Building Regulations (Riley and Cotgrave, 2004)

There is also strong international momentum for promoting education for sustainability building. Bodies such as the Association for University Leaders for a Sustainable Future (ULSF) strongly promote education for sustainability. The 'Talloires Declaration', overseen by USLF, has been signed by over 300 higher education institutions in more than 40 countries to demonstrate their commitment to embrace sustainability and environmental literacy (USLF, 2006). The 'Copernicus Charter', a European follow-up to Talloires, has 320 signatories from 38 countries, (Copernicus-Campus, 2006). In addition, the UN has declared 2005 to 2015 the "Decade for Education for Sustainable Development" (UNESCO 2003) to build on the educational aspirations of the Earth Charter, which embraces the need to cultivate the "knowledge, values, and skills needed for a sustainable way of life" (Earth Charter International, 2006). The direct impact of these international initiatives on UK higher education is difficult to measure. Only nine UK universities have signed the Talloires Declaration, of which just four offer construction-related degree programmes (USLF, 2006) and 32 UK institutions have signed the Copernicus Charter. Nevertheless, within the UK, the policy agenda to promote education for sustainability literacy has a long history.

Table 1.1 alludes to an ongoing commitment from UK governments to promote education for sustainability via various departmental strategies. This commitment is emphasised in the UK's official sustainable development strategy, which asks educators "to make sustainability literacy a core competency for professional graduates" (HMG 2005, p39). Independent bodies like the Forum for the Future have the role of providing badly needed support and guidance to academics wishing to respond to this agenda. (Taken from Murray and Cotgrave, 2007)

Organisation	Initiative	Year
Department for Environment, Food and Rural Affairs (DEFRA)	Establishment of the Council for Environmental Education, to place sustainable development at the heart of education policy and practice (CEE 2002), CEE closed in 2005	1968 - 2005
Committee on Environmental Education in Further and Higher Education	Environmental Responsibility: An Agenda for Further and Higher Education published in 1993 (Toyne, 1993).	1992, reviewed 1996
UK Government (ODPM/DfES)	Sustainable Development Education Panel established	1998
Higher Education Partnership for Sustainability (HEPS)	Three year project with 18 universities and sustainable development charity Forum for the Future, to promote sustainability performance in universities (Parkin et al 2004)	2000-2003
Forum for the Future	Launch of sustainability in the curriculum toolkit (Forum for the Future 2002)	2002
Department for Education and Skills (DfES)	Launch of "Sustainable Development Action Plan for Sustainability and Skills (DfES 2003)	2003
Higher Education Funding Council for England (HEFCE)	Launch of consultation document on Sustainable Development in higher education (HEFCE 2005)	2005
Office of the Deputy Prime Minister (ODPM)	Launch of the Academy for Sustainable Communities to promote the development of knowledge and skills needed to create sustainable communities	2005
Higher Education Academy	Monitoring research in education for sustainability. Launch of initial report on ESD in Higher Education (HEA 2006)	2006
Department for Business Enterprises and Regulatory Reform	Draft strategy for Sustainable Construction- A consultation paper (DfBERR –July 2007)	2007

Table1.1 Initiatives relating to education for sustainability literacy in the UK

However, McKeown-Ice and Dendinger (2000) have identified the fact that scientific knowledge and political intervention will not solve the environmental problem on their own, thus implying that something additional is required to change behaviour. Behaviour changes can only occur if attitudes change and this can be achieved through education, and as Fien (1997) identifies, environmental education can play a key role by creating awareness, and changing people's values, skills and behaviour.

An increasing awareness of the enormous impact of construction work and buildings on the environment and the role that education can play in changing industry behaviour by changing attitudes via environmental education prompted the commencement of this research project. In overview, the project seeks to identify and evaluate interventions that can be made by the Higher Education sector to ensure sustainability literacy in built environment students. This does not mean just increasing the number of lectures on environmental issues in construction programmes, it involves including interventions that will enable students to question their values and change attitudes and behaviour. For as Orr (1992) states:

'a decent environmental studies programme could acquaint students with the major issues .... and still fail because its graduates were unable to make the leap from 'I know' to 'I care' to 'I'll do something'

Initially a review of the construction management undergraduate programme at Liverpool John Moores University, which is accredited by the Chartered Institute of Building (CIOB), was undertaken. This illustrated a deficit in student knowledge and understanding of environmental issues in a built environment context. During presentations by final year students, it was evident that knowledge of environmental issues, specifically sustainable construction and design was very superficial. This was worrying because it was assumed by the programme leader that the curriculum promoted an integrated approach to the teaching of environmental issues that is an explicit requirement of the Chartered Institute of Building Educational Framework (2002). The review identified that although the prescribed curriculum did promote an integrated approach and module leaders were including the topics in their lecture programmes, this did not appear to promote student learning. The initial aim of the research work was therefore to identify how the curriculum could be adapted to enhance student learning in this field. If changes were not made, then as Brough (1994) warns, most students will graduate with only a shallow knowledge of the planet that sustains them. As construction graduates are the construction professionals of the future it is imperative that they have not just sufficient, but significant knowledge of all issues appertaining to the environmental impact of construction and buildings so that they can make informed decisions to reduce this impact during their working life.

It was identified very early on in preliminary investigations that curriculum development involves a number of stakeholders that needed to be consulted as part of the study. These stakeholders have been identified as the government, the Construction Industry, the Chartered Institute of Building and academia. By involving these parties in the research project, it was intended that negotiated criteria and concepts for curriculum development would be developed, which could be utilised to inform curricula in order to improve the environmental attitudes of construction professionals of the future. This could have a positive effect on how the construction industry performs, and reduce the damaging impact that construction activity and buildings have on the environment.

1.2 Research Aim and Objectives

In 1998 the DETR established the Sustainable Education Panel. The aim of the panel was to consider issues concerning education for sustainable development and make recommendations for action. In its First Annual Report(DETR,1999), the Sustainable Development Education Panel set a goal that by 2010 all professional bodies and industry lead bodies should have a sustainable development criteria included within the course accreditation requirements. The Strategic Forum for Construction Report (Egan,2002) states that graduates of construction programmes should be equipped with the skills, knowledge and understanding to meet the challenges of a rapidly changing industry. It specifically mentions the subject 'designing for health, safety and sustainability'.

These are direct responses to the Toyne Report (DFE,1993) finding that although many employers saw the need to 'green' the curricula, it had not so far received the attention it deserved from accrediting professional bodies. The role of the professional institutions is important, acting as repositories of knowledge and as an essential part of the knowledge production system. Gann (2001) reiterates this by stating that professional institutions have an important role to play by strengthening the support infrastructure and liaising with different parties in the knowledge production process-research finding transfer from academia to industry.

In support of the need for curriculum greening specifically in construction programmes, Perdan et al(2000) stated that an effective way to improve the environmental performance of the construction industry in the UK is through the education of students in the tertiary sector. Therefore to achieve a level of environmental literacy that can change environmental attitudes, the extent, level and nature of environmental content in the curricula of construction education programmes needs to be carefully developed.

The overall aim of this research is therefore to produce a set of well-developed concepts that can be used to explain or predict phenomena related to curriculum modelling. These concepts will be derived from data that has been systematically gathered and subsequently analysed and will relate to UK Construction Management curricula, focussing specifically on the area of environmental issues. The concepts and the model developed may be used to supplement existing professional body guidance for curriculum design that aims to promote literacy in sustainability.

Objectives

The aim will be achieved after the following objectives have been addressed:

1. Determination of the level of consensus of the terms sustainable development, sustainable construction and sustainable design in the context of construction and buildings.
2. Evaluation of attitudes of the construction industry to sustainability and proactive innovations that are being undertaken.
3. Analysis of the CIOB Educational Frameworks 1994, 2002 and 2007 to illustrate how these guides promote sustainability in the curriculum of construction and property programmes.
4. Analysis of educational models for curriculum design for HE construction programmes, and the options that are available to universities to improve the curriculum from an environmental perspective. This is from both student knowledge increases and value questioning perspectives.
5. Determination of the level and scope of environmental issues required in the construction and property curricula and current curriculum strategies employed at UK universities to embed these
6. Analysis of the current status in UK Universities with regard to how priority areas are included in the curriculum.

7. Analysis of how priority areas are included in the curriculum internationally, using Australia as the case study, to identify possible aspects of good practice that could be used in the UK.
8. Proposal of interventions necessary and development of a model for an effective sustainable curriculum and investigation of its applicability to UK HEIs.
9. Implementation of the findings via the redevelopment of the construction management programme at JMU (the case study).
10. Testing the validity of the findings via a simulation of the model.

1.3 Overview of Methodology

The initial methodology adopted was the undertaking of a thorough literature review, which focussed on the following topics:

1. Defining sustainable construction to identify which elements of sustainability need to be included specifically in construction management programmes, in order to identify what construction management students need to know about environmental issues.
2. The impact the construction industry has on the environment, and how the industry can improve on its performance in order to determine what level of environmental literacy is required of construction management students.
3. Determination of what environmental education involves and recommendations as to how it can be successfully developed. This was required to try to identify the extent that education influences student learning and attitude formation. It also aimed to identify the barriers that can prevent more environmental focus being included in the curriculum.
4. Reviewing professional body course accreditation requirements.
5. Approaches to curriculum design and development in order to determine what is considered good practice with regard to developing environmental literacy in students.

The main findings of each stage of the literature review have been summarised and conflicts in the findings and lack of available literature have been identified. The findings of the literature review have been used to formulate the research questions that needed to be answered.

A further literature review was undertaken to determine the most suitable methodology for the collection and analysis of data that could answer the formulated questions. Alternative methodologies were evaluated to ensure that the most suitable methods were utilised. There were three phases of data collection and analysis and the specific details of collection and analysis undertaken in each phase are outlined briefly in the following sections and in more detail in the relevant chapters. There was also a stage where the model that was developed following phases 1 and 2 was implemented. Testing of the model is referred to as phase 3.

1.3.1 Phase 1

After consideration of the review it was deemed necessary to collect primary data initially from the HE sector and industry in order to confirm or refute the results of the literature review. The initial collection of primary data is described as phase 1.

The objectives of the primary data collection for phase 1 were:

1. To gain insight into present curricular situation concerning the environment, the stakeholders' own evaluation of that situation and to identify principles for greening of curricula.
2. To gain an insight into students' concepts and understanding of the environment.
3. To gain an understanding of how the construction industry has adopted environmental policies and how much importance is placed on protection of the environment from damage caused by the design and construction of buildings. This data was collected using questionnaires and the sample group were Local Authority building works departments. This sample was chosen at this stage because it was believed that as the vast majority of Local Authorities had signed up to the Local Agenda 21 initiative, there would be more pro-activity regarding sustainability in construction and buildings than in the private sector.

The phase 1 data collection took the form of semi structured interviews undertaken over the telephone with twenty two programme leaders of Construction Management undergraduate courses in the UK. This information was supplemented by the use of a questionnaire sent to final year students on these programmes.

Data was collected from Construction Industry representatives via a questionnaire sent to all the Local Authorities in England and Wales.

1.3.2 Phase 2

Analysis of phase 1 data led to further gaps in knowledge being identified and the need for richer data to be generated to clarify and/or verify the findings of phase 1. For this to occur a reduction in the original sample was required and a qualitative approach to data generation developed. Sampling was undertaken using cluster analysis based on a sampling grid in order to generate a suitable sample. Face to face interviews were undertaken with Construction Management programme leaders at institutions included in the sample. In order to identify if there was any good practice being undertaken in countries where environmental problems are more visible than the UK with regard to curriculum greening, an international perspective was introduced. To remove the problem of language, only English speaking countries were considered. The country where there are cultural, languages, technical and educational similarities, is Australia. The same interview questions were asked of programme leaders in Australian universities. This part of the research project is described as phase 2.

1.3.3 Model implementation

Following the analysis of the phase 2 data, a model for curriculum design was developed. This model was used to inform the curriculum re-design of the Construction Management programme at LJMU, termed the case study for the purpose of the research project. Before implementation of the model, an attempt was made to gather data from industry to provide support for the principles developed. The constraints of this data collection and evaluation of industry feedback are discussed in chapter 6.

1.3.4 Phase 3

To test the validity of the model, the interventions and the validity of the findings from phase 2 a methodology needed to be developed. In order to test the success of the curriculum design, data on student knowledge, skills and attitudes would need to be collected from students on the programme at every level in June 2008 and then every year after that until the first set of graduates from the new programme complete in June 2012. This would take the work for this PhD study well out of prescribed time. Therefore the approach taken for testing is the simulation of the principles of the model in a one week intensive project undertaken by final year students. Knowledge and attitudes were tested before, during and after the project. The assumption is that even if there is only a slight improvement in the three aspects over the week, over three years the improvement should be significant.

The rationale for the approaches taken in phases 1, 2 and 3 and the model implementation will be detailed later in the thesis.

1.3.5 Research Methods

The research project adopted a mixed model methodology approach throughout. In mixed model methodology work, a combination of qualitative and quantitative data collection and analysis tools are used in each stage of data collection. This differs from a mixed methodology approach which normally uses both methods at different times during a research project, but independently (Niglas, 2000). The rationale for this approach is detailed in chapter 3.0

Although a mixed model methodology approach was taken, there was a greater emphasis on either qualitative or quantitative approaches in each phase. The different approaches of application of the mixed model methodology to data collection and analysis will be explained in chapter 3.0 and the rationale for the application of the approaches will be detailed fully in chapters 4.0, 5.0 and 7.0. Figure 1.1 summarises the data collection and analysis stages and the predominant methodology that has been identified. Phase 1 was predominantly quantitative, phase 2 qualitative and phase 3 quantitative. However, the data collection methods and analysis tools used in each phase of the project were a mix of qualitative and quantitative.

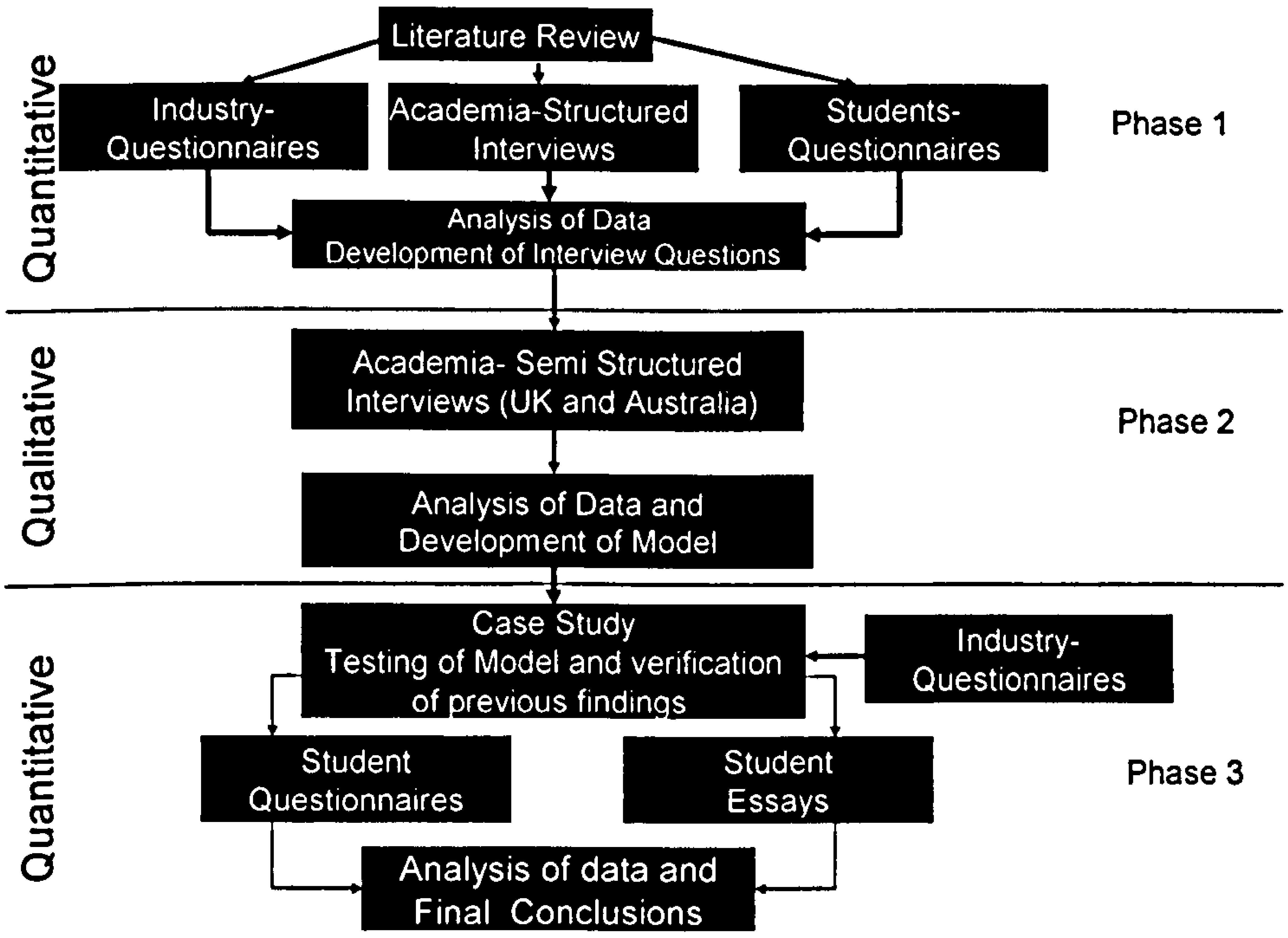


Figure 1.1 Overview of Stages of the Research Project and Methodology

1.4 Thesis Structure

The thesis is structured into 8 chapters plus references, a selected bibliography and appendices.

Chapter 2 summarises the main findings of the literature review in four areas:
Sustainability in the context of construction and buildings- this section aims to identify what is it that construction students need to know in order for them to become environmentally literate.
Industry approaches to sustainability- this section aims to outline how the construction and property industry has changed or adapted approaches to core business in light of the environmental agenda for change.
Professional body approaches to curriculum greening- the main focus of this section relates to how the CIOB Educational Framework has developed over time and how the framework promotes the development of literacy in sustainability. Other professional body approaches are also briefly discussed.
Curriculum design and environmental education good practice –this section aims to identify how curriculum design for the promotion of literacy in sustainability

should be approached and discusses innovations that could and/or have been adopted by UK HEIs.

Chapter 3 discusses potential methodologies that could be used for the collection of primary data and evaluates the advantages and disadvantages of different approaches. The methodologies adopted for phases 1, 2 and 3 are justified and a brief overview is given of the method of implementation of the chosen methodology and mechanisms used to analyse the collected data.

Chapter 4 discusses issues relating to phase 1. It includes a detailed rationale for the methodology, results of the data collection, method of analysis of the data, results, analysis and conclusions.

Chapter 5 discusses issues relating to phase 2. It includes a detailed rationale for the methodology, results of the data collection, method of analysis of the data, results, analysis and conclusions.

Chapter 6 This chapter describes the development of a curriculum design model for the integration of sustainability into the construction curriculum using the findings of chapters 2, 4 and 5. Industry feedback on the model is given and the method of implementation of the findings into a case study at LJMU is outlined.

Chapter 7 discusses issues relating to phase 3, which is the testing of the model. It includes the detailed rationale for the methodology, results of the data collection, method of analysis of the data, results, analysis and conclusions.

Chapter 8 summarises the conclusions from the research project and identifies the contribution to existing knowledge from this work. Suggestions for continuation of the research are presented.

A CD is also included that contains further appendices.

1.5 Summary and hypothesis

The introductory chapter describes the context, introduction, overview of approach taken to the project and need for the research. It also outlines the structure of the project. As has already been stated the momentum for research into sustainability from industry and academic perspectives has developed enormously since the research work started. However, the tools developed are very applicable and could significantly improve the construction curriculum from a sustainable perspective, especially if adopted by the Chartered Institute of Building.

The overall hypothesis to be tested in this project is as follows:

'Well researched and applied curriculum interventions in sustainability may improve student knowledge, and positively change attitudes and behaviour in construction professionals of the future'

2.0 Literature Review

2.1 Introduction

The aim of the literature review is to identify issues that are relevant to the overall aims and objectives of the research project, and to identify parameters for future data collection. Initially, an attempt to answer a number of questions has been undertaken. Perhaps the biggest question at this point though is to identify what it is that students on Construction Management need to know, and this is partially answered by evaluating the type of work that the majority proceed to upon graduation.

Graduates of Construction Management degree programmes generally progress into careers with construction contracting organisations, and therefore are involved in the management of the construction process using traditional methods. Therefore they need to understand the principles of sustainable construction. In addition to this the number of graduates who progress to working in contracting companies that undertake design and build work is increasing. Chart 2.1 illustrates the split between procurement routes in the UK in 2004 and chart 2.2 illustrates the rise in popularity of design and build as a procurement route from 1984 to 2004 (Ross, 2008)

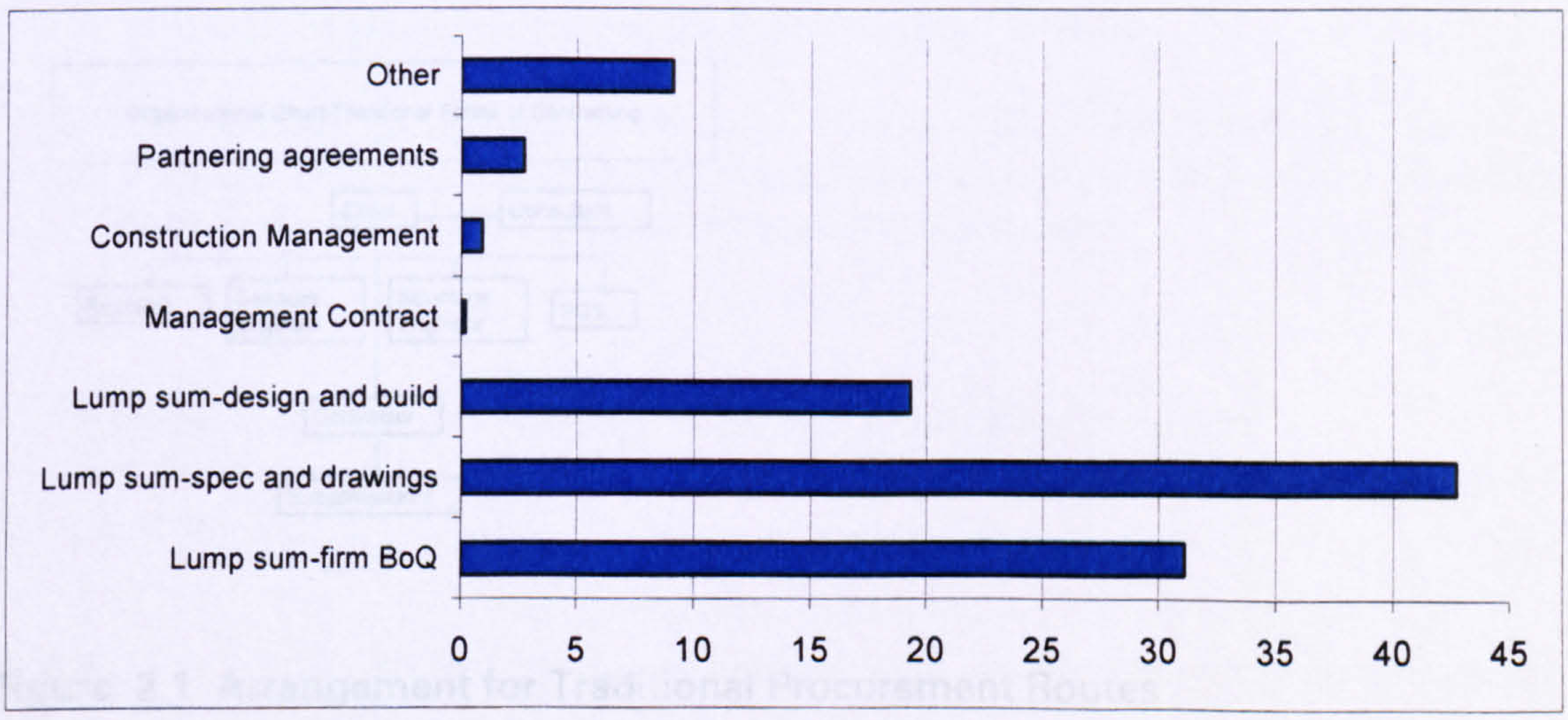


Chart 2.1 Percentage of contracts undertaken using different contract types in 2004

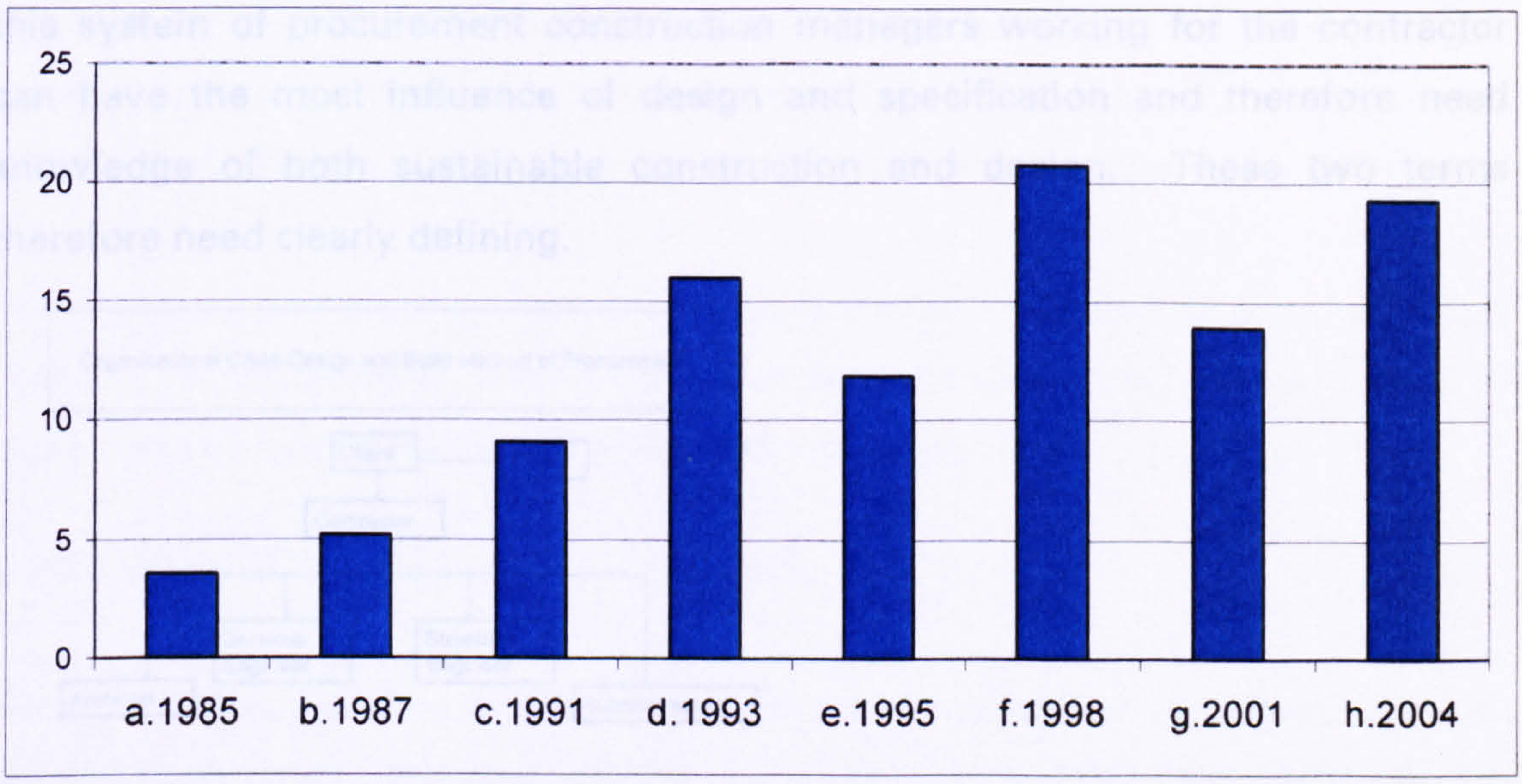


Chart 2.2 Percentage of total number of contracts procured using design and build (Original source: Contracts in Use survey RICS 2004)

The use of design and build procurement is maintaining momentum and the implication of this finding for the research project is that construction management graduates need to be well versed in the principles of sustainable design. In traditional contracting as shown in figure 2.1 contracting staff do not get involved in the design process. The design is produced by the architect, services and structural engineers and then the work is tendered for by the contractor. The contractor does not therefore have any influence over the design and specification of systems and materials (Ross, 2008).

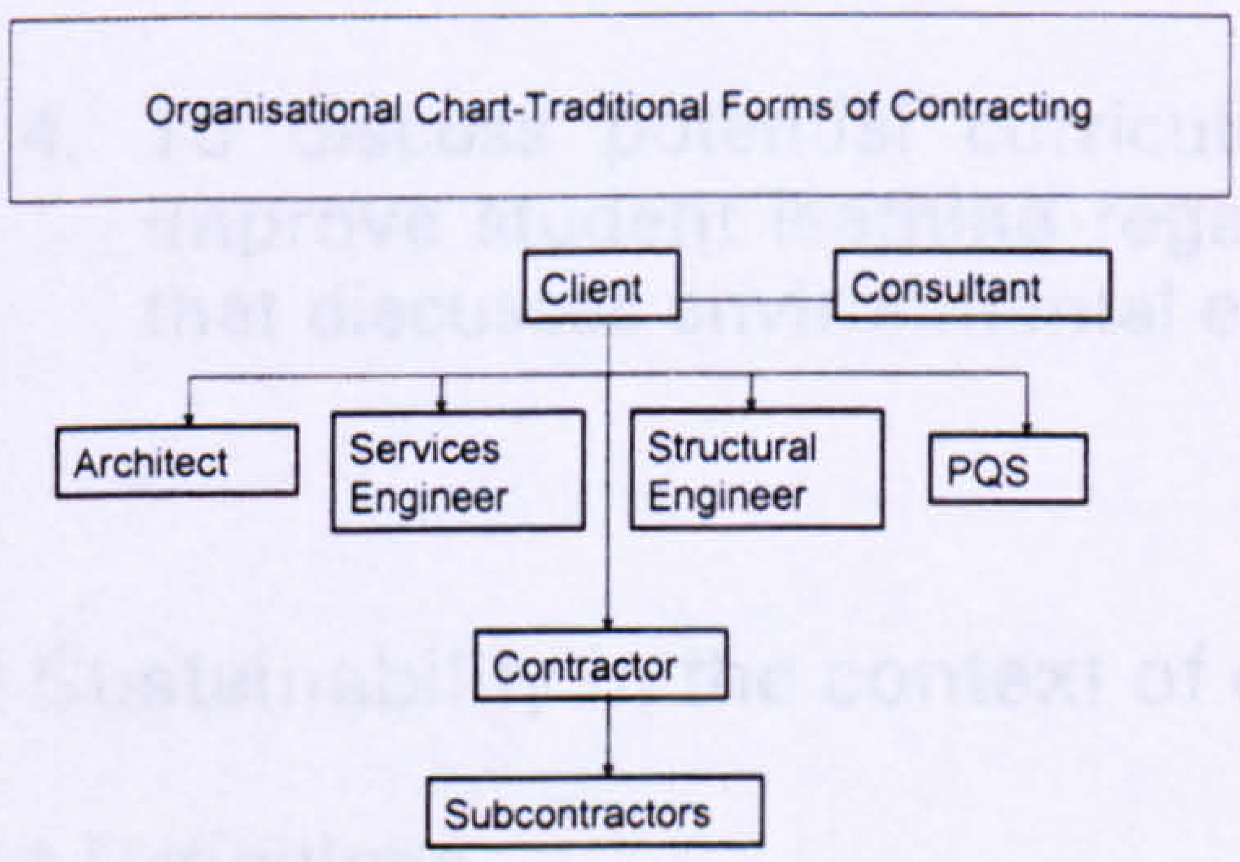


Figure 2.1 Arrangement for Traditional Procurement Routes

In design and build contracting as shown in figure 2.2, the designers work for the contractor and produce a complete design. The contractor then prices the work and submits a tender based not only on cost and time, but also on design. For this system of procurement construction managers working for the contractor can have the most influence of design and specification and therefore need knowledge of both sustainable construction and design. These two terms therefore need clearly defining.

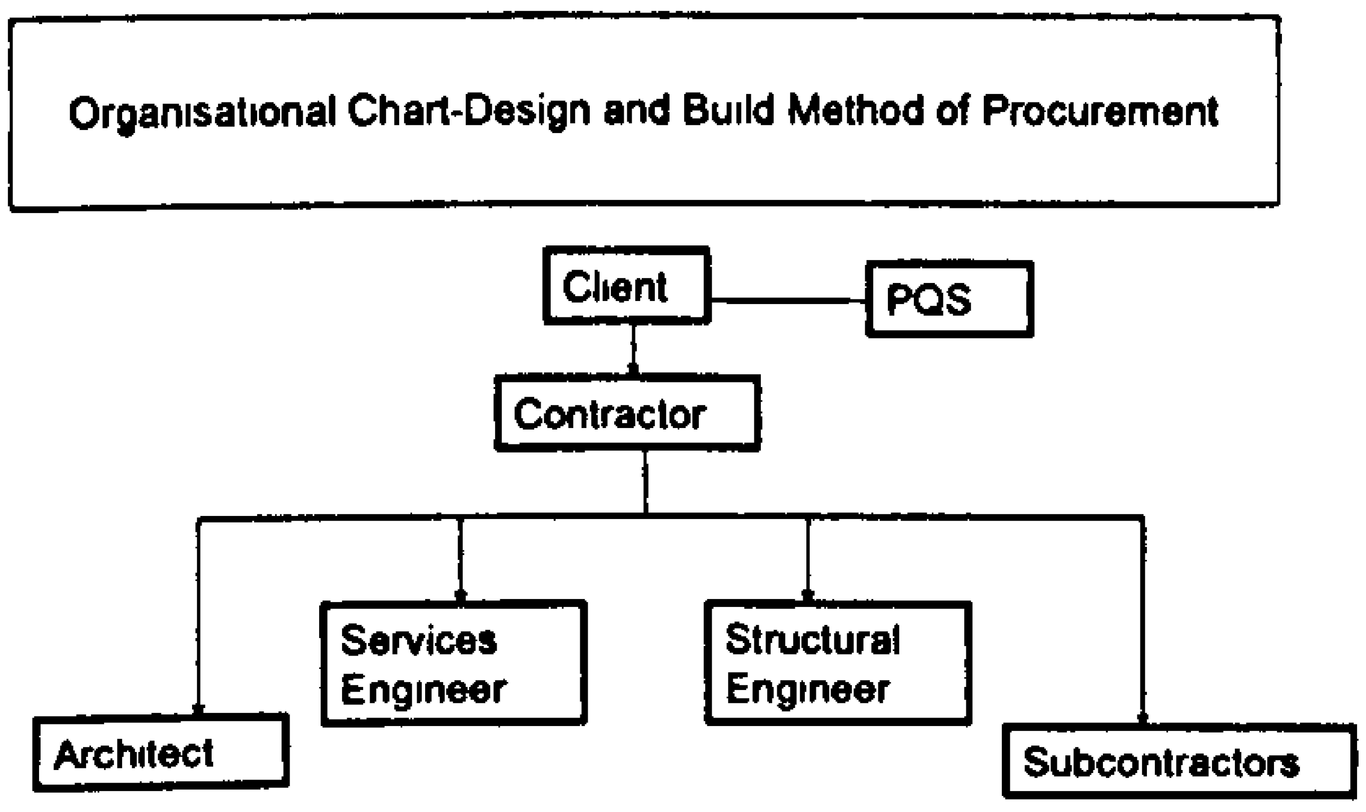


Figure 2.2 Arrangement for the Design and Build Procurement Route

2.1.1 Objectives of the literature review

In the context of the previous section, the objectives of the literature review are:

1. To define what sustainability means in the context of construction work and buildings
2. To identify current industry practices in promoting sustainable deign and construction
3. To evaluate the role of professional bodies in promoting educational strategies that should promote sustainability literacy
4. To discuss potential curriculum interventions that could be used to improve student learning regarding sustainability by reviewing literature that discusses environmental education strategies.

2.2 Sustainability in the context of construction and property

2.2.1 Definitions

The first objective of the literature review is to determine what sustainability means in the context of construction and buildings for the purpose of the research project. There are many definitions that will be considered, but in order to focus the project very clearly, a set of simple definitions needs to be developed that are easy to understand and translate into workable strategies.

The definitions that are required for the purpose of this project are for sustainable design and sustainable construction. Both of these terms are subsets of sustainable development which in turn is a subset of sustainability generally.

In order to define what sustainable construction and sustainable design actually mean, it is necessary to discuss the evolution of these terms from the broader definitions of sustainability and sustainable development.

2.2.2 Sustainability and Sustainable Development

Sustainability as a term is often associated with issues around 'keeping alive', 'continuing', and 'enduring' (Murray and Cotgrave, 2007). In 1987 the UN Commission on Environment and Development (The Brundtland Commission) used the term 'Sustainable Development' to relate the concept of sustainability to human endeavour. The ensuing Brundtland Report then defined sustainable development as:

'*Development which meets the needs of the present without compromising the ability of future generations to meet their own needs*' (WCED, 1987)

This, the most commonly quoted definition of sustainable development, is entirely appropriate in the context of construction works. However, 12 years later, CIB (1999) explain that the word sustainable literally translated into other European languages means "durable", which assumes that something is hard wearing and has longevity. This definition is certainly not suitable when associated with the construction industry because for example, although concrete is very hard wearing and lasts a long time i.e. it is durable, it cannot be classed as sustainable. The production of concrete relies on the extraction of large quantities of non renewable natural materials, requires energy in its production and high levels of transportation from the place of mixing to the site itself. Therefore, if it is assumed that the majority understanding is that the term sustainability has some element of environmental friendliness in its definition, concrete is very unsustainable. Once all natural non-renewable materials are used, the ability of future generations to meet their own needs will indeed be compromised.

It is this confusion in terminology that has led to a lack of understanding at a basic level, as to how to address the environmental lobby in the construction building industry. Dammann and Elle (2006) claim that the absence of a common language between the different actors involved in the building process is a major barrier towards the consideration of environmental aspects. This is rather concerning as the term sustainability was first used in 1987, by Brundlandt.

The Brundlandt definition of sustainable development is very broad but is used as the basis for the explanation given by Langston and Dingk (2001) for sustainable development:

'It (sustainable development) is one of the most important issues facing the quality of human habitation of the planet in the future, and must be addressed now if an effective balance is to be struck. It involves proper valuation of environmental goods and services, taking a long-term view of development decisions and seeking to provide equity both within the current generation and across generations'

This definition alludes potentially to construction work because it refers to the valuation of environmental goods, which can be interpreted as construction systems and materials. However, again, to the lay person this definition is still not clear as to which elements of sustainable development can be addressed by construction, and allow for clear aims and objectives to be developed.

ICLEI (1996) defined sustainable development as:

"development that delivers the basic environmental, social and economic services to all residences of a community without threatening the viability of natural, built and social systems upon which the delivery of those systems depends"

This view of sustainable development is illustrated graphically by Clift (1998) who adds to this definition by including eco-centric concerns which encompasses environmental services and protection of ecology and including technology alongside economic issues.

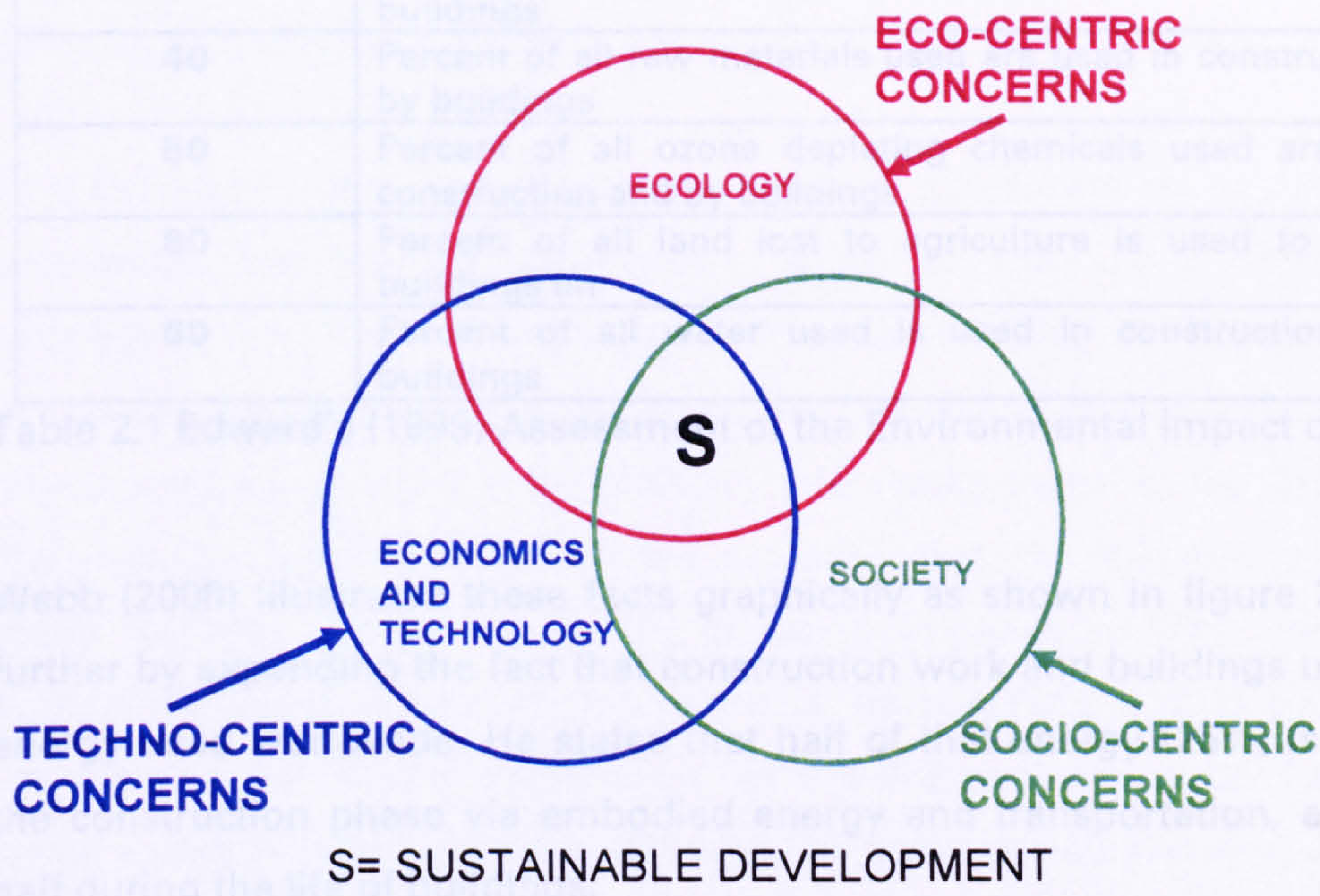


Figure 2.3 Clift's (1998) model of sustainable development

This model eventually illustrates in more meaningful terms, where construction work and buildings fit into the sustainable development agenda and is supported by Leal Filho (2000) who identifies that sustainable development can mean:

'The modality of development that enables countries to progress, economically and socially, without destroying their environmental resources'

All of society is influenced by buildings, to live, work and pass leisure time in. The level of building work is usually linked to the economy of a country or region and all buildings contain technology. Buildings form the corner stone of society and reflect the economic wealth of countries and regions at given times in history, and potentially all building work will impact on the ecology of an area through modification of the natural environment. Most relevant though, construction work and buildings have an impact on the environment.

Edwards (1999) summarises the adverse effect of the construction industry on the environment in table 2.1.

50	Percent of all energy used is used in construction and by buildings
40	Percent of all raw materials used are used in construction and by buildings
50	Percent of all ozone depleting chemicals used are used in construction and by buildings
80	Percent of all land lost to agriculture is used to construct buildings on
50	Percent of all water used is used in construction and by buildings

Table 2.1 Edward's (1999) Assessment of the Environmental Impact of Buildings

Webb (2000) illustrates these facts graphically as shown in figure 2.4, but goes further by expanding the fact that construction work and buildings use 50% of all energy used worldwide. He states that half of that energy (25%) is used during the construction phase via embodied energy and transportation, and the other half during the life of buildings.

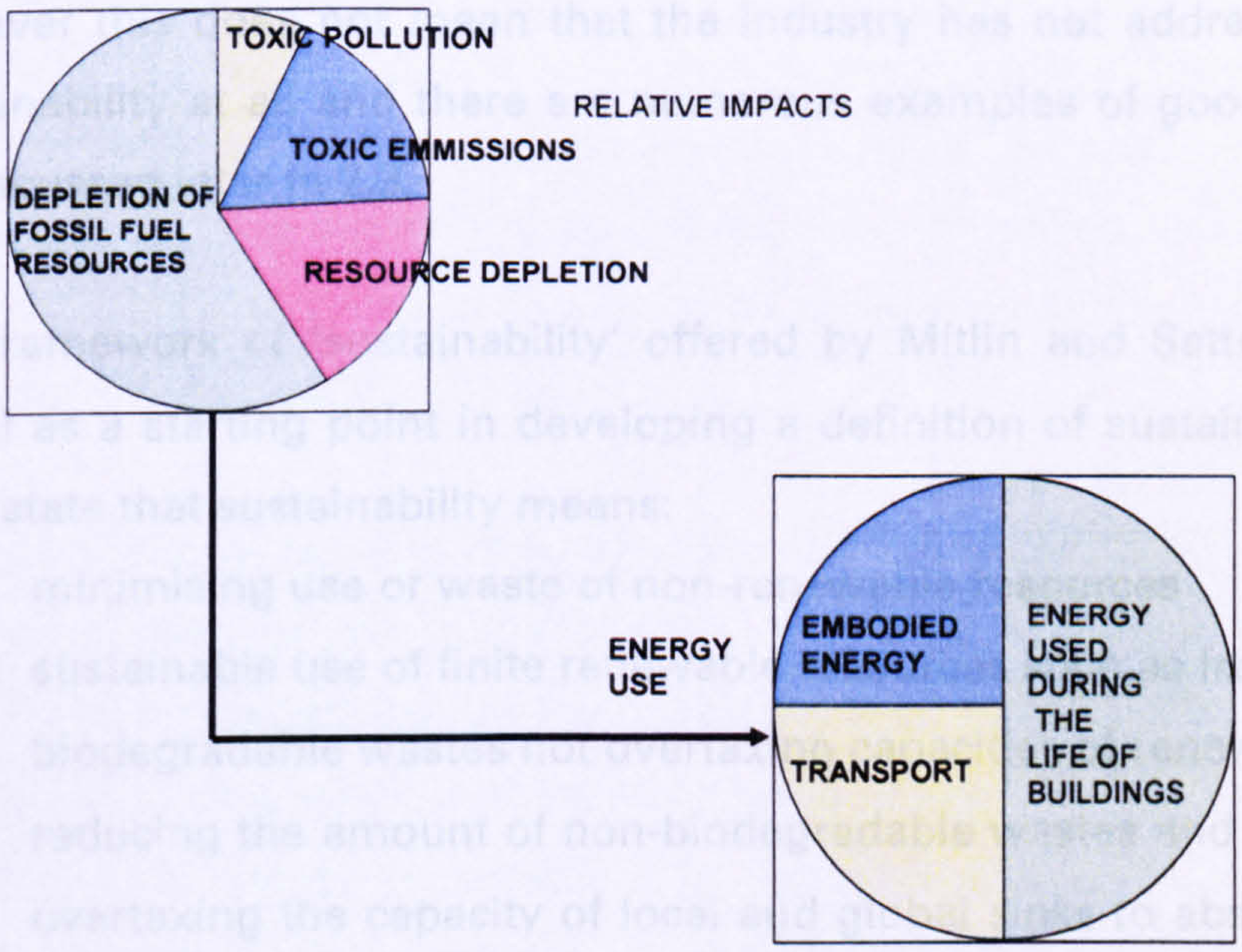


Figure 2.4 Webb's (2000) model showing the environmental impact of construction and buildings

These findings illustrate that due to the enormous impact that construction and buildings have on the environment, any significant change in practices to reduce these impacts could have a very positive effect in reducing and slowing down environmental degradation. The findings also reiterate the need to determine definitions of sustainable construction and design that can easily be translated into workable strategies and operational policies by construction companies.

2.2.3. Sustainable Design and Construction

As has been stated, the previously quoted definitions of sustainability and sustainable development are broad. If all of the above ideologies were addressed, then the real impact on the industry would be substantial, but the definitions are open to interpretation due to a lack of clarity, which is the most effective barrier to prevent the industry addressing these issues (Edwards,1999). The industry needs clearly defined activities that can be addressed relatively easily without having a major financial implication. The definitions for sustainable development, if they were to be achieved, would require change amongst all the players involved in the development of the built environment, which would require long term strategies at local and national level with a certain amount of financial incentive and/or detailed legislation.

However this does not mean that the industry has not addressed the issues of sustainability at all and there are numerous examples of good practice that will be discussed later in 2.3.

The framework of 'sustainability' offered by Mitlin and Satterthwaite (1996) is useful as a starting point in developing a definition of sustainable construction. They state that sustainability means:

a) minimising use or waste of non-renewable resources
b) sustainable use of finite renewable resources such as freshwater
c) biodegradable wastes not overtaxing capacities of renewable sinks
d) reducing the amount of non-biodegradable wastes and emissions and not overtaxing the capacity of local and global sinks to absorb or dilute them without adverse effects. (Ofori,1998)

This framework can be adopted for either the construction phase of a building project and/or the whole life of the building which Langston and Dingk (2001) believe to be important. They believe that a development that performs well in terms of sustainability is one that maximises its contribution to society while minimising its use of energy (both embodied and operating), and its impact on the environment in the construction AND the post construction phases which are linked to design. The calculation of the use of energy during the occupation phase requires a great deal of analysis and is complicated by the following:

- maintenance provision
- occupier understanding of installed services
- longevity of installed systems
- planned life span
- possible changes in legislation and regulations
- change in attitudes towards the environment etc.

Given that most buildings are planned on a 60 year life cycle this is a near impossible task. The BRE state that:-

'A cradle to grave assessment appears at first sight to be the most complete and comprehensive and hence most justifiable. However...large numbers of assumptions must be made about the use phase of the materials and products over typically long time scales for buildings' (Woolley and Kimmins,1999).

Therefore you would need to keep 'your fingers crossed' for 60 years in order to establish whether those predictions are correct. However if the Construction Industry continues to perform as it does now, then the damage in 60 years may be irreversible. Hence action needs to be taken now and can only be taken in the design and construction phase.

Embodied energy is defined by Woolley and Kimmins (1999) as the total amount of energy used in the raw materials extraction and manufacture of a given quantity of a product and by Treloar (1997) who defines direct embodied energy as the input of energy purchased from producers used directly in a process including the energy to construct it. He goes further in stating that indirect embodied energy includes the energy embodied in inputs and services to a process. Further research has demonstrated that the embodied energy of building construction can be up to 50% of the total energy flow of a building over it's life cycle (Adalberth,1994; Pullen,1996; Treloar,1996; Mackley,1998).

It is therefore very valid to concentrate on reducing the amount of embodied energy used in construction as a means of reducing damage to the environment. The energy requirements and impact of a building over its life, although calculated as whole life costs, are fundamentally linked to the design of a building and therefore an understanding of both sustainable construction and design are relevant.

Cole (2000) concurs with the importance of employing sustainable construction techniques:

> *'The initial production of a building can span a period of up to 15 months. The construction practices and procedures during this period are typically the most significant from an environmental standpoint'*

Whilst Anastas and Zimmerman (2003) concur with the importance of sustainable design and its impact over the life of a building:

> *'Sustainable design should encourage reuse and recycling: Products, processes, and systems should be designed for sustainable performance in a commercial 'afterlife'.'*

The definition of sustainable construction developed for the purpose of the research project will therefore concentrate on the design and construction phase as it has been identified that long term performance of the building is mainly, and should be, linked to the design and construction phases.

Woolley and Kimmins (1999) define sustainable construction as the essential element that is required for a building to move towards being completely environmentally friendly, and that the environmental impact of all its constituent parts and design decisions must have been assessed. There is therefore a great deal more to the process than just adding a few 'green' elements such as solar panels' (they use the term green building in the same context as sustainable construction)

R&B Vale (1991) believed that a green approach to the Built Environment involves a holistic approach to the design of buildings that all the resources that go into a building, be they materials, fuels or the contribution of the users need to be considered if a sustainable architecture is to be produced. Although this is a very old reference it shows much foresight and clarity of understanding of sustainable design.

The Building Services Research and Information Service (BSIRIA, 1996) quoted in Edwards(2005) define sustainable construction as the creation of responsible management of a healthy built environment based on resource efficient and ecological principles which include:

1. Minimising non-renewable resource consumption
2. Enhancing the natural environment
3. Elimination or minimising the use of toxins

Woolley and Kimmins (1999) expand these points when identifying the principles of green building:

1. Reducing energy in use, for example using passive as opposed to mechanical ventilation.
2. Minimising external pollution, for example using dust and noise free systems for demolition.
3. Reducing embodied energy and resource depletion, for example choosing refurbishment where possible, reducing waste, and using materials from renewable sources.
4. Minimising internal pollution and damage to health.

These definitions can all be linked back to the Brundlandt (1987) definition of sustainability, any activity must neither degrade nor deplete natural resources nor have serious impacts on the global environment which is to be inherited by future generations e.g. extraction of stone, production of plastics etc.

Edwards (1999) also identifies that aspects of the construction process as well as systems and material choices are important, for example procurement, assembly, site planning and organisation, and commissioning.

Using these explanations of the meaning of sustainable construction and the framework for sustainability suggested by Mitlin and Satterthwaite(1996), the Actions for Sustainable Construction suggested by Skates et al.(2001) and the assessment of building methods guide devised by Cole(2000), a workable definition of sustainable construction can be identified.

To achieve the goal of construction work being labelled as sustainable, the choice of materials and systems must be considered using an environmental preference method and non-sustainable materials and

systems must only be used when there is no feasible alternative, materials must be re-used wherever possible, site run off must be reduced, excavation methods must be carefully considered, waste must be sorted, storm water contained, and waste and tipping minimised. In addition, the choice of procurement method should be considered in the context of promoting environmental protection.

Holm (2006) expands on this and includes in his definition both sustainable construction and sustainable design:

'Sustainable architecture is the design of sustainable buildings. Sustainable architecture attempts to reduce the collective environmental impacts during the production of building components, during the construction process, as well as during the lifecycle of the building (heating, electricity use, carpet cleaning etc) This design practice emphasises efficiency of heating and cooling systems, alternative energy sources such as passive solar, appropriate building siting, reused or recycled building materials, on-site power generation (solar technology, ground source heat pumps, wind power), rainwater harvesting for gardening and washing, and on-site waste management such as green roofs that filter and control stormwater runoff. Sustainable architects design with sustainable living in mind'

Kibert's (1994) early definition of sustainable construction:

"the creation and responsible management of a healthy built environment based on resource efficient and ecological principles"

has therefore been expanded to become a more user-friendly definition, which actually explains the specific procedures that can be undertaken by the industry in order to ensure that building design and construction work is sustainable.

These principles and definitions will be used to inform the basis of what students on construction management programmes should know about sustainability.

2.3 The Construction Industry and the Environment

2.3.1 Introduction

The CIB(1997) identify the importance of the role of the construction industry in achieving a sustainable world with their statement:

'The pursuit of sustainable development throws the built environment and the construction industry into sharp relief. This sector of society is of such vital innate importance that most other industrial areas of the world society simply fade in comparison'

and Bordeau (1999) reiterates this claim by stating that:

'the built environment constitutes one of the main supports (infrastructure, buildings) of economic development, and, on the other side, its construction has significant impacts on resources (land, materials, energy, water, human/social capital) and on the living and working environment. Hence the construction industry has significant direct and indirect links with the various aspects of sustainable development'

Given these findings that are supported by the technical data provided in 2.2.2, it is clear that the construction industry is of major importance in the sustainable development debate. In this section of the literature review, the following aspects will be addressed:

- Further identification of the impact the construction industry has on the environment.
- The structure of the UK construction industry and identification of the type and amount of construction work that is undertaken in the UK
- The nature of the industry including outlining the main procurement routes that are used and the relationship of them to sustainable construction ideals.
- Strategies that construction companies have adopted to date with regard to sustainable construction, and the progress that is being made.
- The barriers that may prevent change in the industry
- Actions that could be taken to improve the acceptance of sustainable construction principles by the industry.

2.3.2 The Impact the Construction Industry has on the Environment

The findings of CIB (1997) and Bordeau (1999), the statistics generated by Edwards(1999) and the diagrammatical representation of these figures by Webb(2000) are corroborated by Langston and Dingk (2001), the CIB(1999) and Graham(2000). They reiterate the importance of the construction industry to the sustainability issue, because of its size and impacts, by identifying that the built environment normally constitutes more than half of the real capital, and construction represents a major part of the Gross National Product (10-12%), in the European Union plus half of all energy used in the world is used in construction work and buildings.

These facts become even more worrying when it is predicted that the world economy will quintuple in size over the next 50 years, and as the construction industry is linked to the economy (it is a commonly known statement that the construction industry is the barometer of the economy), then construction output is predicted to rise at the same rate (A Guide to World Resources, 2000-2001). Construction is therefore acknowledged to have real and potential adverse impacts on the environment and well being of the population of the world over time if changes are not made to current practices (Ofori,1997).

Construction professionals can play a vital role in re-thinking the way we construct the built environment and also in management structures and styles (Graham, 2000).

The aim of a construction project, in most cases, is to complete the development at the lowest cost and as quickly as possible, whilst achieving the standard of quality prescribed by the client. There are certain conditions and standards that must be observed such as health and safety etc., but the majority of considerations are financial. This is not an unreasonable situation as the whole ethos of a business is to make a profit, but the situation causes considerable problems for the environment not just at local level but globally, and to such an extent that our quality of life is threatened.

2.3.3 The structure and nature of the UK construction industry

To understand why the construction industry has been slow to address the issue of sustainability in its practices, an understanding of its structure and the procurement routes it uses needs to be gained.

The UK Construction Industry is characterised by a large number of small contractors and a relatively small number of large contractors that carry out most of the industry's workload (Cooke and Williams, 1998). To illustrate the point, a total of just over 163,000 firms are operational in the industry but 70% of turnover of construction work in generated by only 5000 firms. The gross turnover changes dependant on whether the economy is in boom or bust mode but the percentages stay largely the same (DTI, 2001). Ross (2008) lists the top contractors by turnover in 2006 and these figures support the earlier findings of Cooke and Williams.

It is more likely that the larger companies will have the resources and expertise to develop environmental policies in their strategic plans, which is good news, but it also needs to be recognised that in 2006, £34.2bn worth of turnover was generated by the smaller companies which is a huge amount of construction work that is undertaken by companies without the resources to develop environmental strategies.

The construction industry is well known for its 'adversarial' atmosphere and predisposition towards disputes and litigation. It is also influenced by many external factors beyond its control which contribute to its cyclical and 'stop-go' nature. Tender margins in the industry are notoriously low and the fiercely competitive climate frequently results in the squeezing of subcontractors' and suppliers' prices and the pursuit of claims against clients.

This intensely competitive environment has done great harm to the fabric of the industry and many clients have been unhappy with the service they receive from the construction industry. Often relationships between participants in the construction process are strained by poorly planned and designed projects, lack of communication, mistrust, self interest and disputes which often results in delay, disruption and extra cost (Latham,1994).

However, negative attitudes within the industry are slowly changing and increasingly more importance is attached to client satisfaction both in terms of fewer disputes and less litigation and with respect to repeat business through quality and through partnering arrangements.

To try to change the nature of the construction industry and improve performance, the UK Government commissioned a number of reports.
'Constructing the Team' was published in 1994 by Sir Michael Latham and aimed to 'Review the Procurement and Contractual Arrangements in the UK Construction Industry'. This report is commonly referred to as the Latham Report and is a valuable report in many respects but particularly so as it describes the cultures and methodologies of the construction industry and identifies the factors which militate against the successful outcome of projects.

'Rethinking Construction' was published in July 1998 and represents the work of a special Task Force to identify the scope for improving quality and efficiency in construction. The report, now commonly known as the Egan Report, has recommended the development of a number of new initiatives.
These include:

- Movement for Innovation
- Construction Best Practice Programme and
- Inside UK Enterprise

Movement for Innovation – or m4i as it has become known – comprises a 'board' of members whose task is to co-ordinate a number of 'demonstration' projects, to disseminate 'best practice' information and to oversee industry-wide benchmarking.

The Construction Best Practice Programme provides information for firms wanting to improve aspects of their performance.

The idea behind Inside UK Enterprise is for top performing companies to have an 'open day' where other firms can visit and find out how things are done by the 'host' company.

Egan undoubtedly recognised both the good and bad in construction and sought to build on those aspects of the industry which are excellent in a world-wide context.

One of the problems with the Report is that the emphasis is placed on the 'top-end' of the industry whereas Latham looked at the fundamental problems of the entire industry.

So, whilst 'Egan' has led to the development of several good ideas and worthwhile aims the concepts may take some time to 'filter' down to the lower echelons of the industry. Surprisingly however, there is no mention of sustainability in the Latham Report and only one mention in the Egan Report- paragraph 58- that calls for greater priority to be given to the design and planning stage of construction to 'flexibility of use, operating and maintenance costs and sustainability' (Woolley and Kimmins,2000). However, following the publication of the report, Key Performance Indicators (KPIs) for construction have been introduced. These KPIs allow construction companies to benchmark their performance in different aspects against national standards and averages.

They can then decide which aspects of their organisation need to improve. Encouragingly the revision of KPI groups in 2003 includes a whole set of Environmental KPIs. See table 2.2.

KPI Groups

National Benchmarking data is available for the following KPIs

All Construction Economic KPIs

- Client Satisfaction – Product
- Client Satisfaction – Service
- Defects
- Predictability – Cost
- Predictability – Time
- Profitability
- Productivity
- Safety
- Construction Cost
- Construction Time

New Build Housing KPIs

- Client Satisfaction – Product
- Client Satisfaction – Service
- Defects
- Predictability – Cost
- Predictability – Time
- Profitability
- Productivity
- Safety
- Construction Cost
- Construction Time

Housing R&M and Refurbishment KPIs

- Client Satisfaction – Product
- Client Satisfaction – Service
- Defects
- Predictability – Cost
- Predictability – Time
- Profitability
- Productivity
- Safety
- Construction Cost
- Construction Time
- Employee Satisfaction
- Staff Turnover
- Sickness Absence
- Safety
- Working Hours
- Qualifications & Skills
- Diversity
- Training
- Pay
- Investors in People

Respect for People KPIs

- Employee Satisfaction
- Staff Turnover
- Sickness Absence
- Safety
- Working Hours
- Qualifications & Skills
- Diversity
- Training
- Pay
- Investors in People

Environment KPIs

- Impact on the Environment – Product & Construction Process
- Energy Use (Designed) – Product
- Energy Use – Construction Process
- Mains Water Use (Designed) – Product
- Mains Water Use – Product
- Construction Process Waste – Construction Process
- Commercial Vehicle Movements – Construction Process
- Impact on Biodiversity – Product & Construction Process
- Area of Habitat Created / Retained – Product
- Whole Life Performance – Product

M&E Contractors KPIs

- Client Satisfaction – Design
- Client Satisfaction – Installation
- Client Satisfaction – Service
- Client Satisfaction – Quality of O&M Manual
- Defects
- Predictability – Cost
- Predictability – Time
- Productivity
- Profitability
- Safety

Construction Consultants KPIs

- Customer Satisfaction – Overall Performance
- Customer Satisfaction – Value for Money
- Customer Satisfaction – Quality of Service
- Customer Satisfaction – Timely Delivery
- Customer Satisfaction – Health and Safety Awareness
- Training
- Productivity
- Profitability

Construction Products KPIs

- Customer Satisfaction – Product Quality
- Customer Satisfaction – Delivery Reliability
- Customer Satisfaction – Sales Advice
- Customer Satisfaction – After-Sales Service
- Customer Satisfaction – Value for Money
- Environment – Energy Consumption
- Environment – Water Usage
- Environment – Waste Reduction
- Environment – Transport Movements
- Environment – Packaging Management
- People – Safety at Work
- People – Sickness Absence
- People – Training
- People – Qualifications
- People – Equality & Diversity

Table 2.2 KPI groupings, 2003 revision

The final report in this series was again written by Sir John Egan, was published in 2002 and is commonly referred to as Egan 2 although its title is 'Accelerating Change'.

This report has two main strands: the management of the supply chain and addressing 'people issues', but it does also make proposals relating to sustainability issues in construction. It recommends that an integration toolkit is produced that can be used to advise construction companies as to how they can improve their performance in certain areas, and one of these areas is sustainable construction. There is a section that identifies that sustainability in its broader sense of corporate social responsibility is also a driver for change, and that sustainability cuts across all aspects of construction work. Interestingly there is a comment about the lack of mention of sustainability in the 1998 report, stating that sustainability did not feature because it was important at that stage to focus on the fundamental flaws in construction procurement process. This appears to be rather short sighted, because as can be seen in this thesis, the issues of sustainability in construction were deemed to be very important to many people in 1998.

The lack of mention in the Latham Report and the first Egan Report do highlight that even at the most senior level of the industry, sustainability did not emerge as an important issue until 2002. Even in the 2002 report, sustainability is not the main theme of the report and the main issue addressed is not sustainability per se, but rather waste reduction.

These reports were intended to transform aspects of the industry, and if at this most senior level sustainability is not seen as a major issue then this will not filter down to construction companies.

2.3.4 Procurement Methods

The effective procurement of construction projects requires a balance of time, cost and quality consistent with the client's requirements and budgetary constraints. It also necessitates the choice of an appropriate procurement methodology tailored to the project as well as consideration of the health and safety issues arising.

Over the past fifteen years or so there has been a significant trend towards design and build methods of procurement especially for high value contracts (Ross, 2008).

Some large clients have procured their projects by other means such as entering into partnering agreements and 'framework' arrangements with preferred contractors.

Whichever choice is made, the client's aversion to risk is often a determining factor and a successful outcome is reliant on the client and his/her team understanding the culture and methodologies of the construction industry and deciding their strategy accordingly.
The principal procurement strategies are:

- Traditional-lump sum
- Non-traditional-design and construct, construction management, management contracting
- Collaborative- partnering (Best and Valence,1999)

2.3.4.1 Traditional

A traditional procurement route may be adopted where the client's design team is appointed to prepare a design before the choice of contractor is considered. This can be thought of as a sequential or 'end-on' process where design and construction is separated by an intervening tendering period.

This method has the advantage of price competition but there is little or no contractor involvement in the design and frequently the design is not complete when construction work starts. This leads to inefficiencies on site and delay and disruption when the design is changed or details are awaited by the contractor. The problems with procuring work in this way for the client are related to the overall aim of traditional procurement, which is to allow for a high level of competition to ensure that the lowest price for the work is guaranteed. However the situations that this can cause may, in fact, lead to increases in cost as the work progresses. If contractors bid for the work with a very low profit margin to reduce overall price, they may have omitted sections of work from the tender bid and will be unable to complete the work for the price submitted. This may result in them trying to increase the profit margin by cutting corners in the quality of the work and the production methods adopted, or they will start to look for a 'claim' from the onset of the building work. All of these scenarios can prove problematical for a client and need to be avoided. From a sustainable construction perspective this can also be a very unsatisfactory way for contractors to bid for work as they may not adopt sustainable construction techniques that may be even only slightly more costly, (even if the company has adopted an Environmental Management System (EMS)), as it will reduce their competitiveness. Also the contractor will have no involvement with the design of the building and therefore any expertise and knowledge they have will not be harnessed at this crucial phase (Ross, 2008).

Alternatively, the contractor may be chosen earlier so as to be involved in the early design stages as well as construction. In this case, management contracting or construction management might be chosen where a fee is paid for the contractor's management services and the work is carried out by 'package' contractors.

The main difference between the two is that a management contractor will be in direct contact with the works or package contractors whilst under construction management these contracts will be direct with the construction client. Management methods are more risky because there is less price certainty but the client can benefit from efficiencies in buildability and time due to the overlap between design and construction. With this method the contractor's knowledge and expertise of all aspects of construction work including sustainability can be passed to the client who may then include in the design brief that sustainable construction features and construction methods have to be adopted. It is debatable as to whether the design will prove more costly, but it will mean that all contractors will be competing on the same footing and they will have to price for including these parameters in their bid.

2.3.4.2 Design and Build

Design and Build arrangements involve the contractor taking complete responsibility for design and delivery of the completed project in accordance with the client's requirements. However, this is only partially true to varying degrees as there are many variants of design and build including develop and construct, design and manage and turnkey which all offer slightly different 'deals'. Time and cost savings are the main benefits of design and build but inferior design quality may be a penalty of the method. There can also be contractual complexities especially where the client engages a 'scope' designer prior to appointing the Design and Build contractor. In such cases the client may wish to have the security of a single point of design responsibility and this might involve the secondment of the scope designer to the contractor.

However, potentially, this could be the best method for sustainability to be incorporated into the design and construction work as the contractor could sell the whole package to the client purely on the environmental credibility of the project. If the client organisation has a strong environmental corporate strategy they may feel that to choose the most sustainable form of construction is the best option, even if it is more costly.

Partnering is not strictly a procurement method - it is more a 'relationship' or arrangement between parties with a common set of goals. The contractual aspects of the arrangement are a separate issue to the partnering agreement.
Such arrangements may be preferred especially where the client will have repeat business. The benefits of building up long term relationships are recognised in the Latham Report in terms of 'improving quality and timeliness of completion whilst reducing costs'

Again this relationship is potentially a tool to enable the contractor to advise the client of the potential advantages of employing sustainable construction practices in the building works, but partnering agreements tend to occur after a contractor has won previous work through the more traditional methods. Therefore if the contractor has little expertise in sustainable construction practices, this will not filter through into the agreement. Also, in partnering relationships, the contactor has little influence over design (Ross, 2008).

The form of procurement least likely to allow for contractors to improve their environmental performance is the traditional route, which is so highly competitive that contractors will have to 'cut corners' if they wish to win the tender, and cost cuttings could be in the form of reducing environmentally friendly practices, whereas the form of procurement most likely to allow for contractors to improve their environmental performance by using better environmental design as a selling point, is design and build. Chart 2.3 shows the changing trends in methods of procurement by % of total value of work.

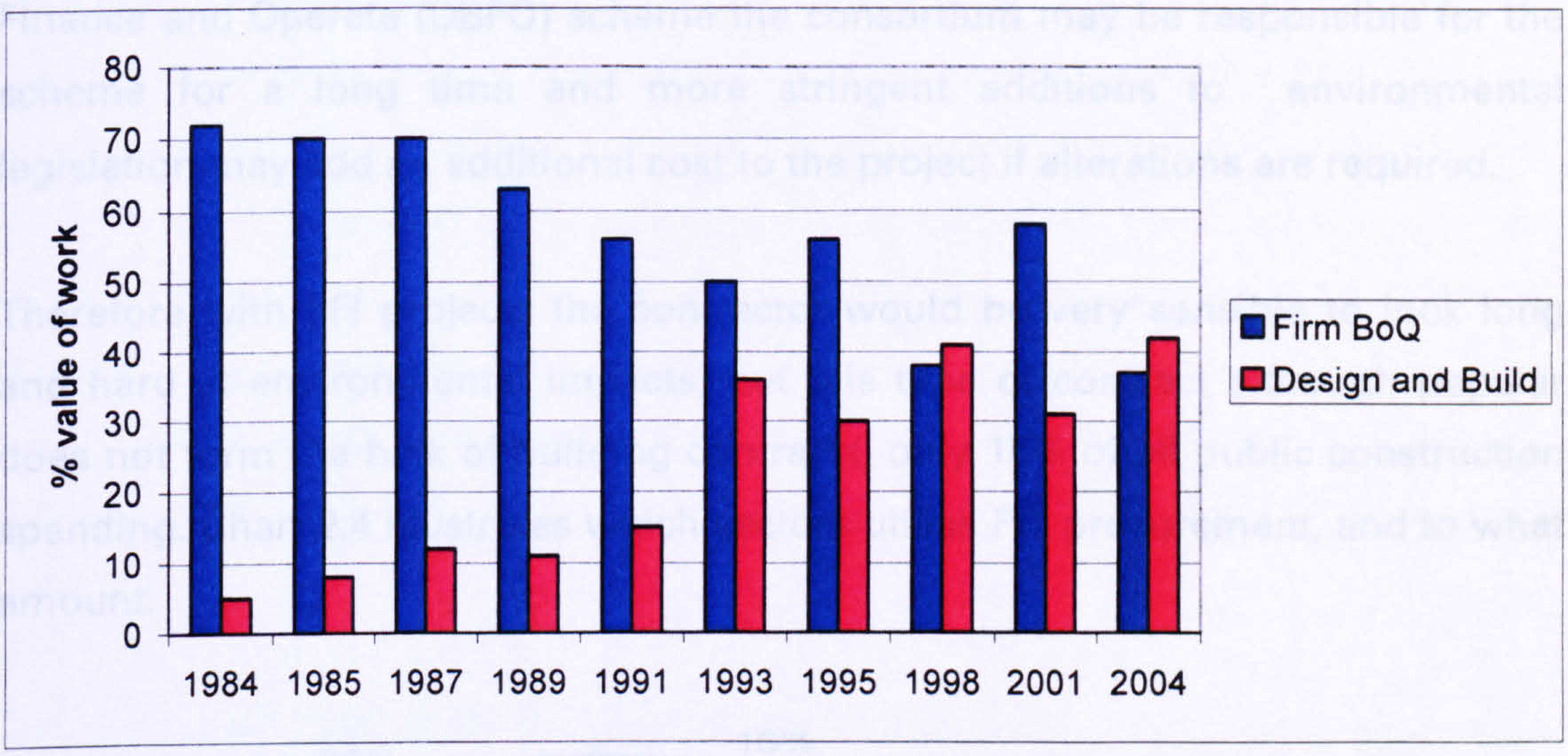
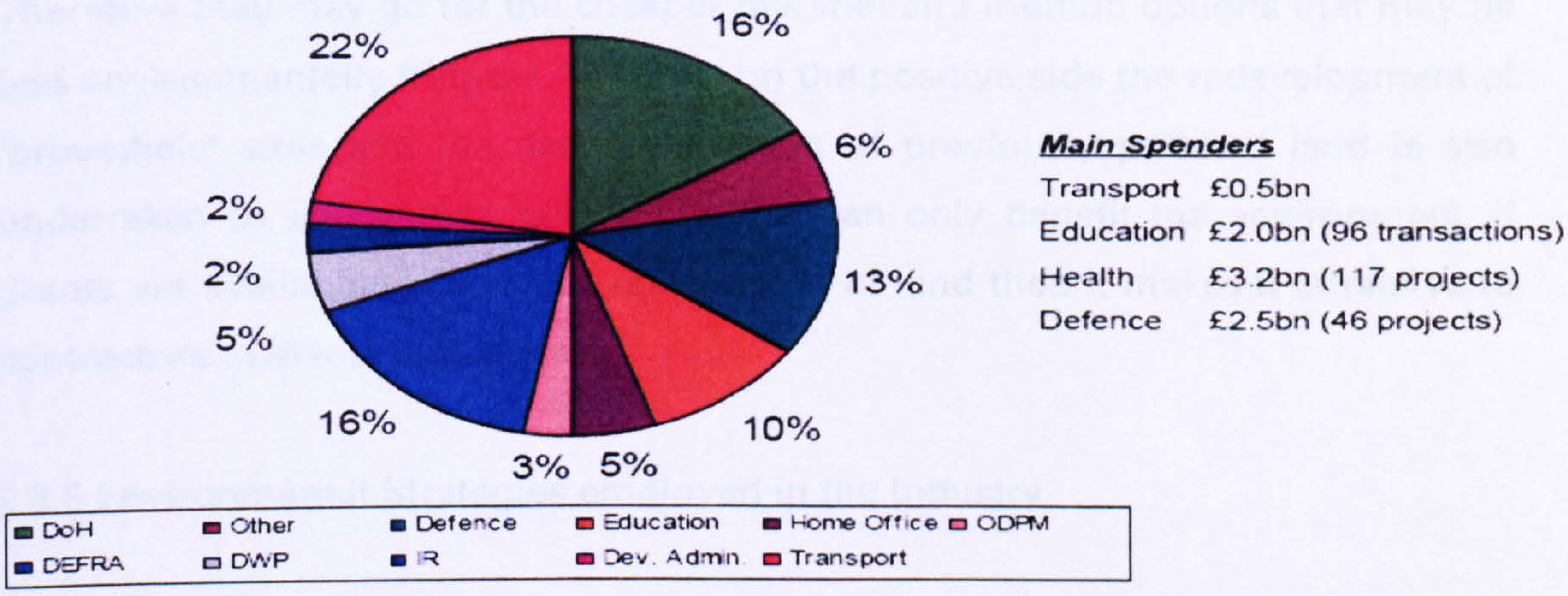


Chart 2.3 Trends in Methods of Procurement- by % of total value of work (figures obtained from Davis Langdon and Everest, 2000 and Ross, 2008)

For publicly funded construction work, the traditional procurement route was 'open' tendering (any number of firms may compete for the works) which is even more competitive than 'selective' tendering (usually a maximum of six companies will be invited to compete for the works). This method was employed because of public accountability, the public needed to know that their money was being spent wisely. The Private Finance Initiative (PFI) procurement route is now being utilised for government funded projects, the difference between this route and traditional procurement is that with traditional procurement routes, the risk lies with the client but in PFI contracts the risk will need to be addressed by contractors (Ross, 2008).

Akintoye (1998) defined the Private Finance Initiative(PFI) as currently the Government's main innovative instrument for the delivery of public services in the UK. It presents the public sector with the opportunity to procure services, or buildings and infrastructure, while leaving the risk of asset and infrastructure ownership and maintenance with the private sector. The two fundamental requirements of the PFI are that the public should secure value for money and that there must be an appropriate transfer of risk to the private sector. Under PFI it is expected that any consortium will comply with all environmental laws, directives and regulations, which is not the case in private development. It is extremely important in this type of scheme that this is the case, as in Build, Operate and Transfer (BOT) schemes the funding will come from public sources and any breach of regulations will not be accepted, and in a Design, Build, Finance and Operate (DBFO) scheme the consortium may be responsible for the scheme for a long time and more stringent additions to environmental legislation may add an additional cost to the project if alterations are required.

Therefore with PFI projects the contractor would be very sensible to look long and hard at environmental impacts, but this type of contract although popular does not form the bulk of building contracts, only 15% of all public construction spending. Chart 2.4 illustrates which sectors utilise PFI procurement, and to what amount.



Source: HM Treasury
Other departments with signed projects are: FCO, LCD, DCMS, Customs, DTI, DWP, GCHQ, HMT IR and the OGC. Figures exclude LUL contracts.

ANTICIPATED UK EXPENDITURE: £4/5bn per year
(= 15% of public investment)

Chart 2.4 Anticipated UK PFI funding

In addition to these differences, the contractor is responsible for the maintenance and management of the construction work over a significant period of time. Therefore it is of benefit for them to consider the environmental impact of the building in use at the time of design and introduce measures to reduce pollution and energy.

2.3.4.3 Speculation

Speculation (Spec) Building is a large part of the construction industry and there are many contractors who specialise in this type of building work, most commonly for housing, but also for offices. This involves the contractors purchasing land, financing and managing the construction work and then selling on the completed property. There is no legal requirement for contractors to incorporate sustainable construction methods into a domestic building project, except for complying with the Building Regulations, and potentially this aspect of the industry could cause even greater damage to the environment than traditional contracting as contractors will want to purchase prime arable land for development, and will want to maximise profit by reducing costs wherever possible.

Therefore they may go for the cheaper material and method options that may be less environmentally friendly. However on the positive side the redevelopment of 'brownfield' sites and the decontamination of previously polluted land is also undertaken by speculative builders, which can only benefit the environment. If grants are available to fund this reclamation of land then it makes it attractive to contractors to invest in this area.

2.3.5 Environmental Strategies employed in the Industry

2.3.5.1 Public sector

Clients' expectations of the service expected from the construction industry are now much more demanding and the preservation of the industry 'status quo' is secondary to the need to satisfy clients' requirements. These include timing, quality level, price certainty, completion, design responsibility and allocation of risk but should also include satisfying environmental constraints if specified. However as Langston and Dingk(2001) believe, public sector projects may put other items on the agenda such as accident reduction, health and well being, pollution, aesthetics and amenity plus environmental standards. Local Authorities for instance may have a Local Agenda 21 (LA21) policy that has been derived from Agenda 21, and all contractors competing for work will need to comply with this policy. O'Riordan and Voisey (1997) define LA21 as the name for initiatives that are being undertaken under chapter 40 of Agenda 21, of which the main requirement is that local authorities should consult with their communities and other stakeholders to reach a consensus on the implementation of sustainable development (by 1996). However as Langston and Dingk believe that in an ideal world, sustainable practices would be sought after as far as is practicable because conserving resources (present and future) would be the obvious thing to do. However in the real world decisions are often made on the basis of profit maximisation to the investor even for public sector projects which although may be generally thought of as more community orientated, monetary evaluation is still dominant.

Therefore although the public sector may not be as proactive as one would think regarding environmental protection, it is nevertheless believed by many including Gouldson and Roberts(2000) that economic and environmental policies are best implemented where there is a high degree of local and regional autonomy(Local Authorities) which allows for the structure and content of environmental strategies to reflect the social and economic characteristics of a particular region.

2.3.5.2 Private sector

Akintoye (1998) identified through his research that construction contractors have not taken seriously the demands of environmental laws and regulations on their business activities and that there is no doubt that environmental matters constitute a financial threat to construction business activities.

One of the main ways of observing changes within the industry is by looking at changes made to the Building Regulations, specifically those that deal with environmental issues. To show commitment to making buildings greener, Nick Raynsford the then Minister for Construction prompted an overhaul of the regulations in 2002, but the starting point to the development of these regulations came largely in 1995. Part L of the regulations deals specifically with environmental issues and in 1995 the main changes to the 1990 edition included:

- Improving the standards of fabric insulation by changing the method of calculation of U-values to take into account thermal bridges such as mortar joint and timber joists and studs.

- Basing the u-values standard for windows, doors and rooflights on double rather than single glazing.
- Changing window areas allowances to include for doors and rooflights
- Including new provisions for reducing thermal bridging around window and door openings.
- Including new provisions for reducing air leakage at windows and doors through the building fabric.
- Improving the standards for the thermal performance of hot water vessels and pipework and ductwork.

These provisions are relevant to all buildings and there are further changes identified that give guidance on the changes relevant to dwellings and the buildings other than dwellings. Guidance relevant to material alterations and change of use was given for the first time with regard to these issues.

The regulations were further revised and came into force on 1st April 2002. The main changes are that standards of fabric insulation have been further improved by changing the methods of calculating U-values to those in European standards and by setting lower(i.e. better) standards (DTLR,2002). The nominal U-value for windows and other glazed elements has been further improved and is now based on 'sealed' double glazed units and the base area allowance has been increased to 25% to give more daylighting design flexibility. Boiler efficiency is covered and the provisions for trading off between fabric and heating system performance have been improved. The guidance on reducing thermal bridging has also been improved and new guidance is given on reducing unwanted air leakage. New guidance is given on complying with the regulations for commissioning heating and hot water systems, and for lighting, and conservatories attached to buildings now have to comply to the regulations for free standing conservatories. It can be seen that the regulations deal predominantly with energy efficiency over the long term, and not specifically with the construction phase, but they are representative of a change in attitude in, certainly, the then Minister for Construction. The biggest change however has been the requirement for contractors on buildings, other than dwellings, to pressure test the building before handover to check for leakage.

The regulations were again revised in 2006, with more guidance given as to how achieve the required standards and some more stringent requirements.

The implications for the contractors who construct larger buildings are great, and unfortunately one of the predictions is that the regulations could spell the end for design and build contracts, as more detailed specifications will have to be produced at an earlier stage. As this has been identified as the procurement route that may most encourage the use of sustainable construction techniques, the revisions may encourage more unsustainable practices rather than reduce them. Also many completion dates will have to be extended because of the requirement to pressure test buildings at the end of the build process, and as Lane (2002) states, this is no form filling exercise, buildings may have to be demolished and completely rebuilt, another possible contradictory effect of the regulations as 50% of energy use is expended in the construction phase. The process could change the way that buildings are designed and to satisfy the requirements of pressure testing, changes to the form of construction may be required that is not sustainable from material extraction or embodied production energy perspectives.

The impact of these new regulations will need to monitored over the next few years, but this approach to change is not always viewed as the most effective, as companies will focus all their energies on merely complying with the regulations as opposed to developing strategies of their own that will improve the organisational environmental performance.

House builders have not been affected to any great extent, it was expected that the use of brick and block for domestic properties would be banned and all new houses would have to be timber frame construction which has not occurred, and apart from a slight increase in cost which would be borne by the vendor, the implications are slight.

Gann(2001) indicated that he found positive signs of change in his research which was related to how research findings from academia feed into industry practices, and that there is now far greater interaction between academic researchers who have produced a great deal of guidance on how to produce sustainable buildings, and industry practitioners than there has been previously.

It can be seen that although the UK construction industry has been slow to embrace the principles of sustainable construction, some progress has been made. The structure and procurement routes utilised by the industry are barriers to speedier responses to the environmental problem that are difficult to overcome, but as O'Riordan and Voisey (1997) and Nagpal and Foltz (1995) identify there is a real need to change the approach to sustainability from that of a chimera to becoming a reality, but change is slow and needs to gather momentum in order to decelerate further damage to the environment.

Ofori (1998) believes, that while progress has fallen short of expectations in many areas as evidenced by the proceedings of the Earth Summit Plus Five in New York in 1997 (The Straits Times,1997), the indications are that construction is not the only industry that needs to improve its performance, it is not being called upon to act in a vacuum, it can access several techniques, policy support and incentive schemes to achieve it's aims and may be compelled to act by statute or market forces.

Building environmental assessment methods have emerged as a relevant means of evaluating the performance of buildings across a broad range of environmental considerations (Cole, 2000). The increase in the development and application of such methods has provided considerable theoretical and practical experience concerning their potential contribution in furthering environmentally responsible building design, construction and operational practices. An important indirect benefit is that the broad range of issues incorporated in environmental assessments requires greater communication and interaction between members of the design team and various sectors within the building industry i.e. environmental assessment methods encourage greater dialogue and teamwork (Cole,1999).

The UK is a member body of the ISO movement and the designated representative organisation is the British Standards Institute (BSI). ISO14000 embodies an approach to environmental protection and it challenges each organisation to take stock of its environmental aspects, establish its own objectives and targets, commit itself to effective and reliable processes and continual improvement, and bring all employees into a system of shared and enlightened awareness and personal responsibility for the environmental performance of the organisation. This new paradigm relies on positive performance of the organisation and the desire to do the right thing, rather than on the punishment of errors. Over the long term, it promises to establish a solid base for reliable, consistent management of environmental obligations (Cascio, 1996).

ISO14001 is a proactive environmental protection strategy in which regulatory compliance is just one of the elements of a more inclusive and all encompassing approach. ISO14001, the environmental management system (EMS) standard provides a framework to direct the use of organisational resources to the full breadth of actual and potential environmental impacts through reliable management processes and a base of educated and committed employees. Companies can try to attain the kitemark of ISO14001 but this is on a voluntary basis, in the long term it may result in the company attaining more work from clients who have strong environmental requirements, and certainly from government but it is likely that only the larger companies will have the resources to implement such a scheme. ISO14000 is an international standard, BS7750 and Europe's Eco-Management and Audit Scheme Regulation (EMAS) are similar standards that companies may wish to be judged against.

Table 2.3 compares the three systems.

	ISO14001	BS7750	EMAS
Type of Standard	Voluntary, consensus, private sector standard	National, voluntary standard	EU regulation
Applicability	Can apply to the whole or part of an organisation. Applicable to organisations activities, products and services, non-industrial organisations and non-profit organisations	Can apply in the UK and other developed countries to the whole or part of an organisation. Applicable to organisations activities, products and services, non-industrial organisations and non-profit organisations	Applies to EU, to individual facilities and site specific industrial activities
Focus	Environmental management systems, indirect link to environmental improvements	Environmental management systems, with environmental improvements emerging from the system	Environmental performance improvements at a site and the provision of communication of improvements to the public
Initial Environmental Review	Suggested, but not required in the standard	Suggested, but not required in the standard	Required in regulation
Policy Commitment	To continual improvement of the environmental management system and to prevent pollution, to comply with relevant environmental legislation AND voluntary commitments	To continual improvement of environmental performance	To continual improvement of environmental performance, to comply with relevant environmental legislation
Audits	Required of the environmental management system, monitoring and measuring of key environmental characteristics, frequency not specified	Required of the environmental management system,, audits for compliance or environmental performance are not required, frequency not specified	Are required for environmental management systems, processes, data and environmental performance. Required at least every 3 years.
Public Communication	Only environmental policy must be made public, anything else left to management to decide	Only environmental policy must be made public, anything else left to management to decide	A description of the environmental policy, programme and management system must be made available to the public annually.

Table 2.3 Comparison of ISO14001, British Standard (BS) 7750 and European Union's Eco-Management and Audit Scheme regulation (EMAS) (Cascio et al, 1996).

BS7750 and EMAS are full-system standards; that is, with these systems virtually no other regulation is needed, whereas this is not the case with ISO14001.

ISO14001 and BS7750 are voluntary schemes whereas EMAS is compulsory to companies who are perceived to create greater risks to the environment.

To attain accreditation under one of these standards a company would have to adopt an Environmental Management System. A typical system is shown in figure 2.5

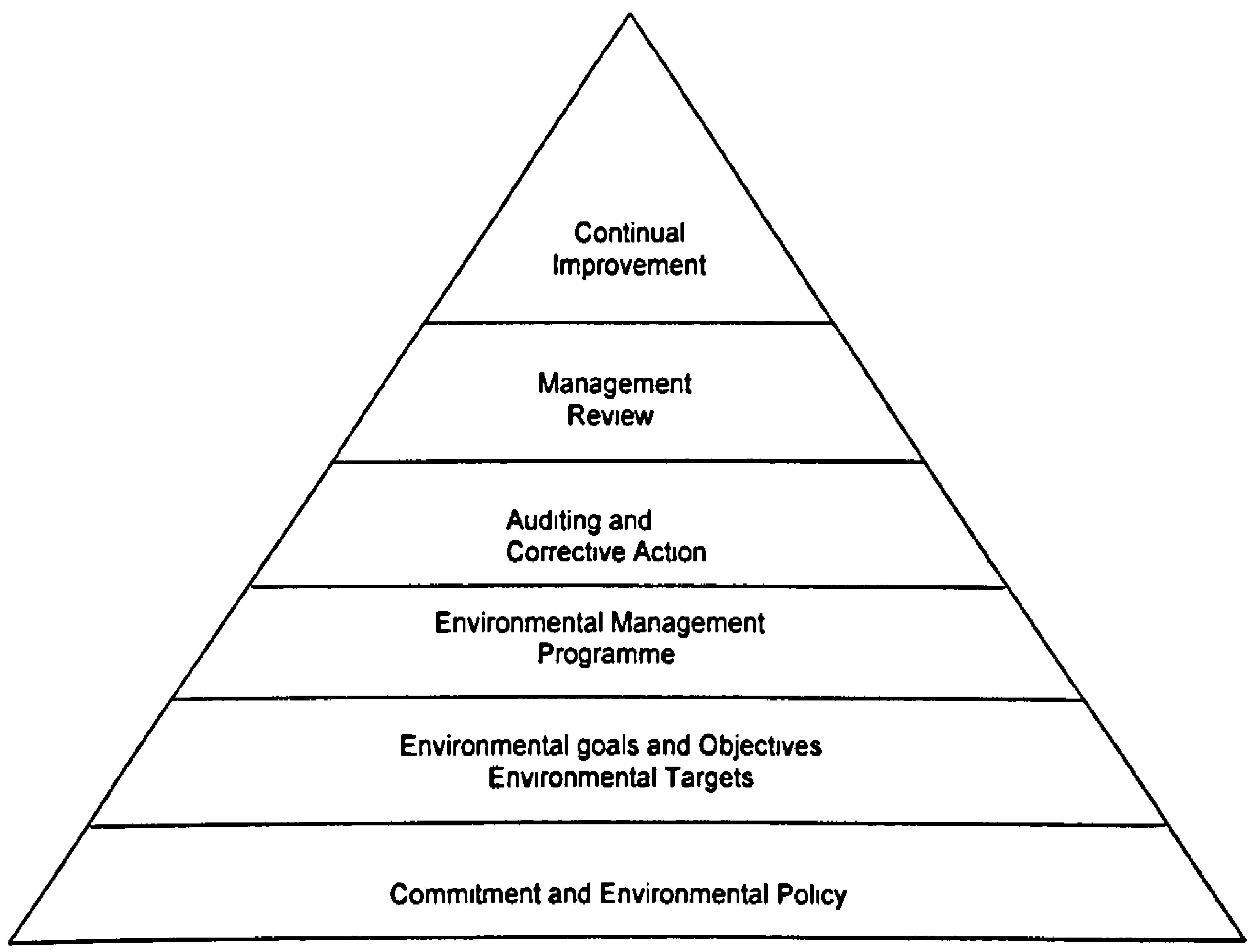


Figure 2.5 Typical environmental management system

Environmental assessment tools can be used to assess how sustainable buildings are once they are built. The five most popular environmental assessment tools being used today are the Building Research Establishment Environmental Assessment Method (BREEAM), the Canadian 'Building Environmental Performance Assessment Criteria' (BEPAC) programme, the US 'Leadership in Energy and Environmental Design(LEED) programme, the Green Building Challenge(GBC) assessment framework and the Hong Kong 'Building Environmental Assessment Method' (HK-BEAM). The most popular in the UK is BREEAM (Cole, 2000).

The Building Research Establishment Environmental Assessment Method (BREEAM) was originally launched in 1990 (Baldwin et al ,1998). It sought to provide authoritative guidance on ways of minimising the adverse effects of buildings and the local and global environments whilst promoting a healthy, comfortable indoor environment. It was a world first and is the best known scheme of its type. The basis of the scheme is a certificate awarded to individual buildings on the basis of 'credits' for a set of performance criteria.

The certificate provides a 'label' for the building that enables the owners or occupiers to gain recognition for the building's environmental performance.

The building is assessed independently by trained assessors appointed by the BRE who are responsible for specifying the criteria and methods of assessment and for quality assurance of the process used. The main objectives are:

- To distinguish buildings of diminished environmental impact in the market place
- To encourage best environmental practice in building design, operation, management and maintenance
- To set criteria and standards going beyond those required by law and regulations
- To raise the awareness of owners, occupants, designers and operators of buildings with a reduced impact on the environment.

BREEAM can be used as an independently verifiable measurement tool for use within Environmental Management Systems from formal certification schemes such as ISO14000 and EMAS, to simple locally developed systems.
BREEAM addresses the following that are relevant to construction companies:

- It allows for assessment of environmental impacts of materials and systems.
- It addresses the use of natural resources by providing durable buildings able to survive changes of fashion and use, selection of materials and products with better environmental performance, encourages recycling, the reuse of the ageing building stock, reuse of land etc.

However building environmental assessment is a rapidly evolving field (Chau et al, 2000). BREEAM 98 for Offices introduced changes to its weighting system so as to have flexibility to accommodate different requirements in different stages of the building process such as design, construction, operation and management. There is much research being undertaken that is directed towards establishing a set of consensus based sustainability indicators, an objective weighting scale and a framework for the assessment scheme. The ultimate goal behind these refinements is to establish the credibility of the scheme by revealing the total impact of the buildings on the environment. However these schemes are voluntary and therefore the success of using such an approach will depend on the building investor's self interest. Despite the high international profile of BREEAM and its significant impact on the commercial property market, only a very slow rate of international market penetration has been observed (Cooper,1999)

The attainment of the ISO14001 or BS7750 standards is an excellent achievement by contracting organisations that shows not only commitment to the schemes but also demonstrates that the company employs personnel that have the correct skills and educational background to ensure the scheme's success. Undertaking schemes that have been checked against and comply with the recommendations of the BREEAM model is also very reassuring, but this may not address the majority of construction work undertaken. Chau et al. (2000) are sceptical about these schemes because they tend to focus on the credibility issue but fail to address the economic concern and values of most developers and designers.

2.3.6 Barriers that can prevent change in the Construction Industry

As has been demonstrated in this chapter to date the construction industry has an enormous impact on the environment and if changes are made to practices then the resulting impact could be major. The previous findings have also illustrated that the structure and nature of the industry do not naturally lend themselves to making the required changes even though there have been recommendations made from the highest level i.e. the second Egan Report, but they do not proactively prevent the necessary interventions. Procurement strategies employed by the industry do not promote changes to industry practices but again they do not prevent more environmentally responsible behaviour and some methods are potentially better than others. There are also a number of industry standards that can be achieved for promoting sustainable construction and design, but the problem with these is that they are voluntary. Therefore there are not insurmountable barriers preventing the industry becoming more environmentally responsible, so why has it not changed more radically to date?

Edwards(1999) and Anink et al.(1996) have identified that although there are barriers to change, change is required and it needs to be driven from those who are peripheral to the industry but who can influence industry practices. They therefore believe that change can only be brought about through legislation. This view is supported by environmentalists and Valence(2000) believes that they (the environmentalists) prefer legislation as opposed to economic incentives and market based solutions as they are generally 'purists' who put the environment firmly on the top of any agenda. However market based solutions may cost considerably less because they will eliminate the need for monitoring and enforcing policy and could also be more popular with the Industry, BUT they will take longer to implement and the effects may be far less wide reaching.

The Toyne Report (1993) findings also concluded that regulation and compulsion cannot achieve all that is required; they are in any case acceptable, in a democracy, only if the need for them is sufficiently widely acknowledged. Therefore, there are conflicting views as to the potential effects of introducing stringent legislation regarding the environment, and it is unlikely that any government will risk alienating industry by hampering their ability to make profits as ultimately this will be a huge vote loser and will be highly unpopular. It is also unpopular with manufacturers as identified by Woolley and Kimmins (1999) who when producing their 'green' building guides hit upon opposition from manufacturers for the industry who produce materials which are viewed as 'ungreen'.

Many authors believe the main barrier is that of the difficulty of grasping the concepts of sustainability and as Langston and Dingk (2001) concur by deferring environmental issues as something to consider in the future, that future attracts a high level of uncertainty about the nature of the problem, it's effect and solution. Hence if something is too difficult, unless the problem becomes apparent immediately it is pushed to the bottom of the agenda. Therefore is it feasible for a company concentrate on sustainability if they are on the verge of financial collapse?

Leal Filho (2000) believes that sustainability as a concept is not accepted widely because:

- It is believed that sustainability is a fashion-hence it will go out of date and therefore it is not worth worrying too much about
- It is an abstract and purely theoretical concept that cannot be achieved in totality
- It is difficult to implement- as Woolley and Kimmins (2000) concur, materials are largely unavailable in the UK and also there are not enough people trained to implement it.
- It is too broad-there is too much to do to achieve it

The barriers to progress documented by the CIB (1997) are:

- Professional and institutional inertia defending the status quo
- Lack of understanding of the problem among construction professionals
- Inadequate vehicles for participation by stakeholders
- Market delay
- Insufficient data
- Lack of communication
- Lack of client 'buy-in'
- Political insecurity-government electoral periods limit the horizon.

Add to these lists potential additional cost and the need for more training and education, and it becomes apparent why there is reluctance by industry to shift their entire methods of working towards total sustainability.

Larsson (2001), a member of iiSBE, the International Initiative for Sustainable Built Environment, which is a group of researchers whose interests are sustainable design and construction, believes that the research work done in this area does not reach potential industry users, or at least not to the level desired by the researchers. This problem is a communication issue and somehow the facilitation of communication between the research community and industry needs to occur, if research is going to have any impact on industry practices.

A further reason for lack of acceptance is that of cost to the client and as O'Riordan and Voisey (1997) quote:

'If a majority honestly does not want to pay what it sees as 'the price' for sustainable development, who is to deny them their legitimate wish?'

They believe that if a country adopts a system of democratic probity, individuals cannot be forced to think of the future and/or pay to protect it if they do not wish to do so.

Indeed as Woolley and Kimmins (2000) believe it may not be the building contractors or architects who are to blame entirely for their lack of momentum. They have found that although there are many environmentally friendly products available in Europe, few of them are sold in bulk in the UK and that the reason that building companies and suppliers in the UK do not use eco-products is that they state that clients are not interested, and if they are not readily available, they go for alternatives. However, in the UK there are indications that the general public are taking environmental issues more seriously. Issues such as the management of waste, problems with water supply due to lack of rainfall and unusual weather patterns have led to a rising awareness that things are changing and that this could be because of humanities actions in the past. Therefore there is a developing impetus to make changes that will stop or slow down any further damage to the environment.

The validity of these findings will be addressed from the analysis of primary data gained from the construction industry and the education sector in phase 1.

2.3.7 Actions that could be taken to improve the acceptance of sustainable construction principles by the Construction Industry

2.3.7.1 Legislation, fines and incentives

The barriers to progress may at first reading seem insurmountable especially when considered in addition to the nature and structure of the industry and with knowledge of well embedded industry practices. However there are actions that can be taken to pursue the ultimate goal relatively simply.

CIB (1997) believe that public awareness needs to be raised and the concept of sustainability needs to be fully accepted by the public at large. They identify that the way to do this is to incorporate environmental costs in the tax system, and further through the use of standards and regulations to render environmental performance measurable and certifiable. More tools are needed such as performance based standards in building codes and 'green' certification and eco-labelling systems based on life cycle analysis. However the opposing view of this is that financial incentives, rewards and motivation are the best tools with which to engender engagement on sustainability.

2.3.7.2 Industry led initiatives-role changes

Industry does need to change and Langston and Dingk(2001) believe that this is where the concept of achieving sustainable development appears to be unfeasible in the UK given the nature of the construction industry, where predominantly lowest price wins the contract and if not lowest price then least duration. The advice given to the client is therefore of utmost importance. When reviewing the procurement routes available to the industry, for traditional routes the designer is the professional that can have the most influence on the client, whereas in design and construct, construction management, partnering and PFI routes the contractor and/or designer will have the most influence. Therefore it is the environmentally educated construction manager and/or designer who are skilled in the communication of their knowledge to clients that should achieve the aim.

Even better would be more working together of all parties involved in the construction process at an early stage which follows Latham's recommendations, but this will only be achieved if professional barriers are to be broken down through interdisciplinary education of designers and constructors particularly in environmental issues.(CIB,1997)

The role of the architect is seen by Edwards (1999) as crucial, and he states:

'Decisions made by architects are crucial to the achievement of a sustainable future'

The CIB (1997) believe this to be the case and state that as the design process will increase in complexity, an integrated approach is required between all parties. Environmental product information systems should assist designers and clients to design more environmentally friendly buildings. They also believe that contractors should see environmental consciousness as a factor of achieving competitiveness and should develop their own services to be environmentally sound. It means reducing the environmental impact of their own business processes e.g. site operations, logistics and material selection and also informing owners of the environmental impact inherent in the building project to ensure that environmental goals are part of the owner's demands.

They must also ensure that they select subcontractors and suppliers based on their expertise on environmental issues. Therefore it is clear that designers and contractors are two of the most important stakeholders in the process and should be the best placed to act as advisors to the client.

Their advice could follow the advice reputedly given by Ruskin (1860) as quoted in Egan(2002):

'It is unwise to pay too much, but it's worse to pay too little. When you pay too much, you lose a little money - that is all. When you pay too little, you sometimes lose everything, because the thing you bought was incapable of doing the thing it was bought to do. The common law of business balance prohibits paying a little and getting a lot - it can't be done. If you deal with the lowest bidder, it is well to add something for the risk you run. And if you do that, you will have enough to pay for something better.'

Shiers et al (2006) concurs with this and places some of the blame for the lack of greening in the industry at the door of clients. They undertook research to assess the reasons why organisations use the Green Guide to Specification and what type of organisations these are. The Green Guide to Specification allows specifiers to choose a traditional system of construction and then easily identify 'green' alternatives. Their research found that the majority of organisations that purchased the third edition were architects (60%) followed by Local Authorities(11%) and when asked when they would use the guide, the architects claimed it was when they were promoting themselves as an environmentally responsible organisation for particular clients and the Local Authorities stated that it was purchased because they may use it because of the growing green agenda.

Therefore neither of these organisation types claimed to be using it for every project. The conclusion to their research was that the problem was with clients not demanding green buildings and that this could be addressed either by new legislation or by changes in the policies of those commissioning the buildings.

2.3.7.3 Strategies for change

The difficulty in implementing a single sustainability strategy has been identified as a major barrier to progress, because of the size and complexity of the industry. Logically, therefore, priority should be given to those parts of the industry with the greatest environmental impact. For building contractors the challenges pertain mostly to material use and the facilitation of material recycling, use of local materials and reuse of serviceable building parts, construction for disassembly using modular approaches, labelling of components to facilitate selective removal and recycling, introduction of quality standards for recycled materials, producing operating and maintenance manuals for buildings and systems, all of which is easily translatable into working practices.

The Greening of Industry for a Sustainable Future report, produced by the Advisory Council for Research on Nature and the Environment and the Greening of Industry Network in 1999 listed four strategies for change which industry could adopt shown in figure 2.6

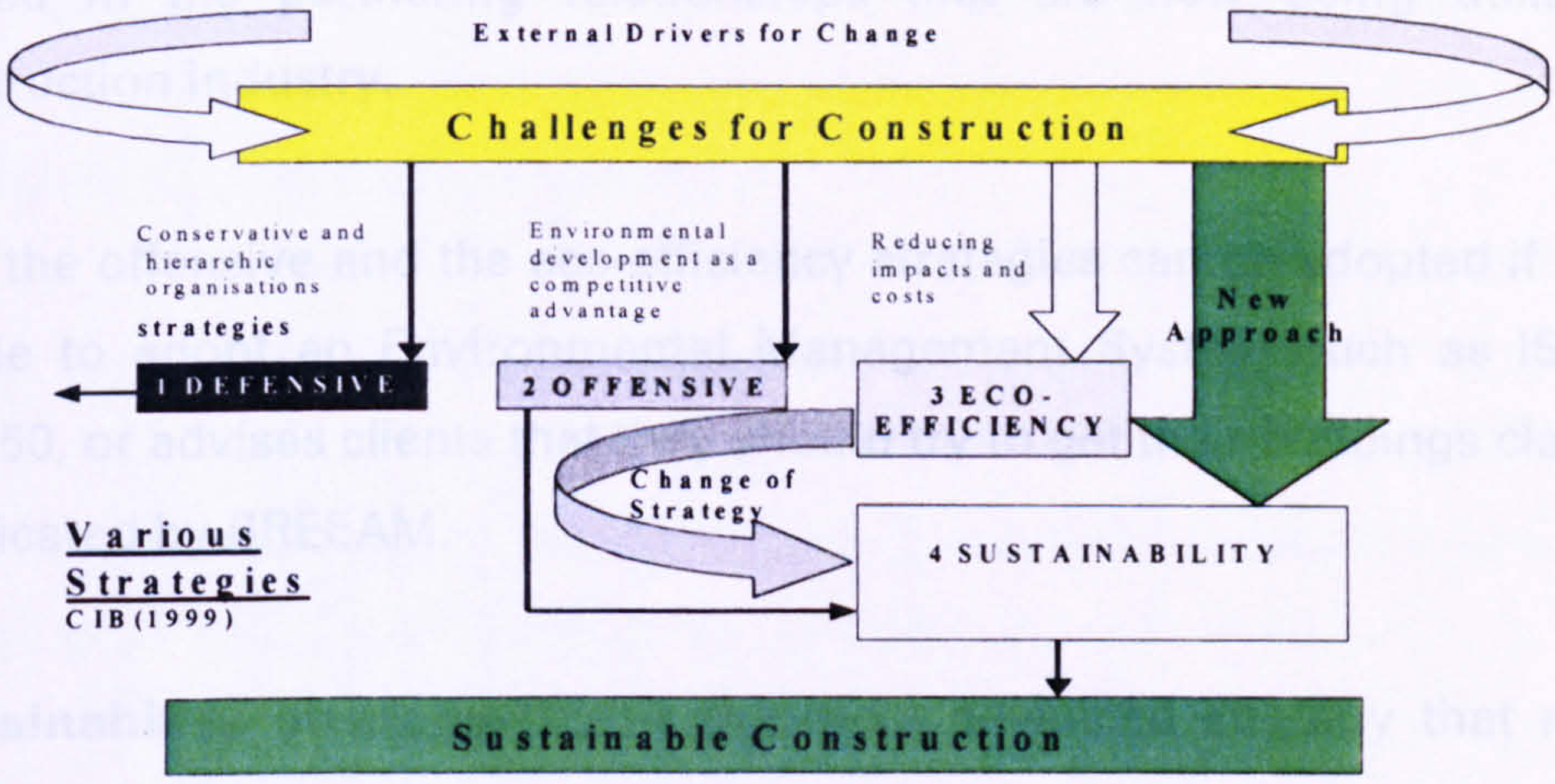


Figure 2.6 Strategies for change (CIB,1999)

The defensive strategy -or complying with regulation. In an industry as competitive as the construction industry one opinion could be that the only way to achieve the aims is to introduce regulations that everyone has to comply with. A contractor will not be penalised in the procurement process as all contractors will be controlled by the same constraints. However it may be that the cost of non-compliance is the most important element as stakeholders may decide it is 'worth the risk' if levels of penalty set are low. It could also lead to environmental impacts being covered up. Typically in organisations that adopt this strategy there are low levels of environmental awareness. Market opportunities arising in this category are specialist consultancy, systems development and monitoring, the development of technologies for monitoring and remediation, environmental monitoring services and development of regulations.

The offensive strategy- beyond compliance. This strategy dictates following a policy of going beyond simple compliance in order to gain a competitive advantage. Environmental components can be demonstrated as market benefits that add value for the client. Improving quality and customer focus are the key requirements needed to move from a defensive to offensive strategy

Eco-efficiency strategy- This strategy tries to identify win-win solutions by reducing environmental impacts and costs and includes concepts such as TQEM(Total Quality Environmental Management) and industrial ecology. It has to be accepted by both the client and the supplier if it is to work and can be best utilised in the partnering relationships that are now being utilised in the construction industry.

Both the offensive and the eco-efficiency strategies can be adopted if a company decide to adopt an Environmental Management System such as ISO14000 or BS7750, or advises clients that they should try to get their buildings classified and certificated by BREEAM.

Sustainability strategy-This is the most advanced strategy that requires an understanding and tolerance of the complexities involved. Decision makers will need to adopt new values that reflect the aims, objectives and aspirations of sustainable development. For the construction industry used to short time horizons with defined, discrete client groups, the risk of including and responding to a range of stakeholders and potential clients may be too high.

For this approach to be fully adopted organisations would need to understand the relationship of the business activity to the impact of the final product. They must care for future generations which may involve including younger people in the decision making process and utilising small work teams to define responsibilities at the lowest level possible. It requires an ability to attend to detail at the site of the problem, and respond quickly and innovatively.

Gann (2001) also believes that firms need to be able to recognise the value of new, external information that represents a key ingredient for innovation, in other words they need to accept research findings generated by the Universities and then fund the development of these theories into workable practices that will improve the performance of the industry.

All of these strategies have been discussed in further detail previously, and it has been identified that by adopting the defensive strategy positive results will be limited. Adopting the offensive and eco efficiency strategies can produce results, the major problem with these is that they are voluntary at an organisational level, and can be viewed as regulation within the company and therefore no different from the defensive strategy. The people who have to implement these systems need not necessarily believe they have any value. To make the most difference, adoption of the sustainable strategy is required and this requires not only policy and regulation but a change in attitudes that will then change behaviour. As has already been stated the way to change attitudes is via education and this is where the higher education sector can assist.

2.3.7.4 Support through Higher Education

According to Leal Filho (1999) the following could be undertaken without a great deal of extra resources from both the industry and the HE sector:

- Fostering the link between the theory and practice of sustainability i.e. industry and academia working together to develop workable systems
- Concentrate on specific issues such as reduction of waste, rather than keep debating the 'wider' meanings of sustainability
- Disseminating the value of sustainability-again this can be achieved through a partnership of academia and industry

Relating these points to the construction industry it is clearly seen that the links between academia and industry are of paramount importance. There have been problems in the communication of research findings from academia to industry. The research may have been too broad and the findings and recommendations seen by industry as being too difficult to achieve. By focussing research on key areas such as waste control the industry may develop an understanding of the relative simplicity of utilising sustainable construction techniques. The importance of the link between industry and academia is also recognised by Wemmenhove and de Groot (2001) who advise academics to train students on how to communicate with the non-academic society, again reiterating the need for research carried out in Universities to then be communicated to industry.

2.3.7.5 Summary and recommendations

The then UK Minister for Construction, Nick Raynsford (2000) in his foreword to the DETR document 'Building a Better Quality of Life' introduces the strategy as a significant milestone to a more socially and environmentally, better regarded construction industry. He also identifies that government alone cannot implement it, the industry and its' stakeholders must assume that responsibility. The impetus for this strategy came from the Earth Summit in Rio de Janeiro (1992), the main product of the Summit being a commitment by 160 world governments, including Britain, to adopt measures on aspects of sustainable development.

This strategy illustrates the need for all the main parties involved in the construction process to become more aware of the principles and practices of sustainable construction. The importance of the contractor and the designer has been evidenced from the literature review, and they can be viewed as the most important parties in the education of the client. Their knowledge of sustainable construction is therefore of paramount importance and the need for more inter professional education to ensure closer collaboration has been identified.

Academia and industry need to work more closely if the vast body or research in sustainable construction is to be related into practice and the industry itself needs to work harder at developing strategies that will bring about changes to working practices. This impetus could come from the professional bodies, in the case of architects the RIBA (Royal Institute of British Architects) and for contractors the CIOB (Chartered Institute of Building).

The aim of sustainable construction is not to reduce the viability of the UK construction industry, but rather enhance it. Many of the principles of sustainable construction relate as much to the principles of best practice as to the environment. And as Whitelegg (1998) states, no one expects the construction industry to abandon a profits driven, commercial perspective, but the intelligent enterprise will be aware of the need to seek out new market opportunities, reduce costs, innovate and improve it's competitive position.

Environmental standards drive a continuous process of improvement in quality and identify opportunities and alternatives for doing things in different ways and in ways that will increase market shares and increase profitability. An environmental concern will lead to higher standards with associated higher costs and more opportunities to build in added value.

Cooke and Williams (1998) believe that as top quality contracting does not come 'cheap' and many of the top contractors have moved away from traditional competitive tendering to negotiated and 'repeat business' projects where the designer and contractor can advise the client, competitiveness will not disappear but rather increase, but the competition will change from being purely financial to more quality, health and safety and environmentally based.
Whilst this may carry a cost penalty to the client it can only be to everyone's benefit to improve these aspects.

The objectives for the industry, the challenges, responsibilities, actions required and barriers to progress are clearly summarised in figure 2.7

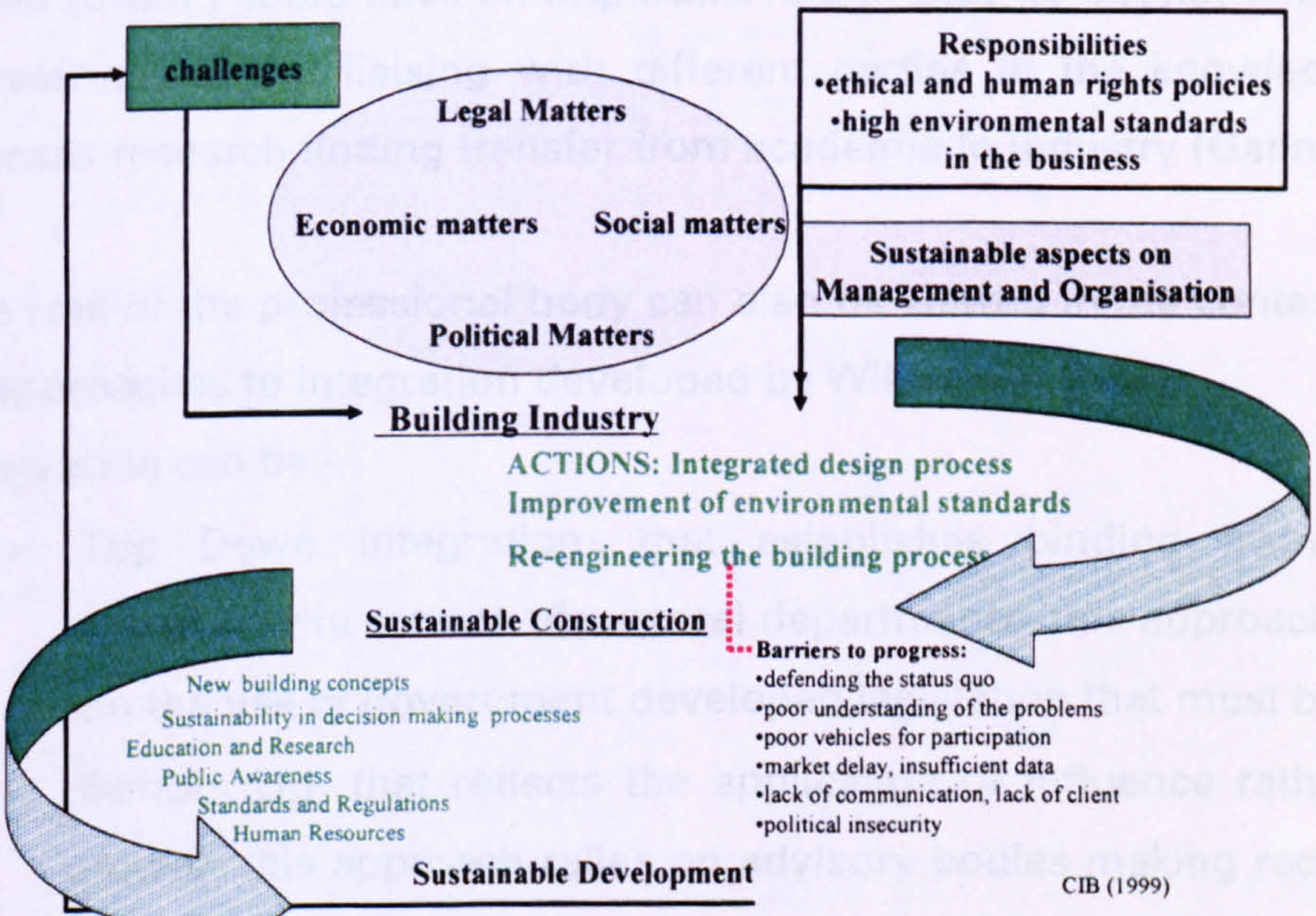


Figure 2.7 The Objectives for the Construction Industry in achieving sustainability (CIB,1999)

2.4 The Role of the Professional Bodies in promoting educational practice that will promote environmental literacy in graduates

2.4.1 Introduction

In 1998 the DETR established the Sustainable Education Panel. The aim of the panel was to consider issues concerning education for sustainable development and make recommendations for action. In its First Annual Report(DETR,1999), the Sustainable Development Education Panel(SDE) set a goal that by 2010 all professional bodies and industry led bodies should have a sustainable development criteria included within the course accreditation requirements (Perdan et al, 2000).

This is a direct response to the Toyne Report(1993) finding that although many employers saw the need to 'green' the curricula, it had not so far received the attention it deserved from accrediting professional bodies The role of the professional institutions is important, acting as repositories of knowledge and as an essential part of the knowledge production system. Professional institutions and industry bodies such as the Construction Research and Innovation Strategy Panel (CRISP) could have an important role to play by strengthening the support infrastructure and liaising with different parties in the knowledge production process-research finding transfer from academia to industry (Gann, 2001).

The role of the professional body can also be viewed in the context of the model of approaches to integration developed by Wilkinson (1997).
Integration can be:-

- Top Down Integration- that establishes binding frameworks which constrain the actions of sectoral departments- this approach relies entirely on the use of government developed legislation that must be enforced
- Bottom Up- that reflects the application of influence rather than formal power- this approach relies on advisory bodies making recommendations to industry. The problem with this approach is that if there is any financial cost then industry may well reject any recommendations.
- Intermediate that falls in between the two- this approach relies on experts who work for advisory bodies making recommendations to government as to what legislation is required and advising how best practice can be

disseminated. This approach will only work if government accepts the findings and recommendations of the experts.

Wilkinson prefers the intermediate approach because his argument is that as there are so many political barriers to achieving top down integration the only way to gain any real effects is by adopting the bottom up approach in order to influence government decisions on legislation that will in turn achieve the intermediate approach, which will be most effective. In order to achieve this, there have to be people who are suitably educated and in a position to influence the authorities of formal power. The professional bodies are the organisations that could take the lead in facilitating the intermediate approach as they are independent from both industry and government.

However there are writers including Watson (2003) who firmly believe that professional bodies should take the complete onus for curriculum design in totality, but this is certainly not a universal view.

It can be seen therefore that the role of the professional bodies and their links to the education sector are viewed as extremely important at the highest level. The aim of this part of the chapter is to establish to what extent, the inclusion of criteria on sustainable development within professional body course accreditation requirements has been achieved to date.

2.4.2 Professions involved in the construction of buildings

As has been stated in previous chapters the research project is focused on sustainable construction and design as opposed to sustainable development that encompasses a wide range of criteria. Sustainable construction concentrates on the work that is carried out at the building stage of a project and includes for concept, design, procurement and construction.

Figure 2.8 illustrates where in the whole life of a building the sustainable construction aspects are most relevant, highlighted as zone 1. There are a number of professions that will be included in this phase, but the most relevant are those that are included in the decision making process.

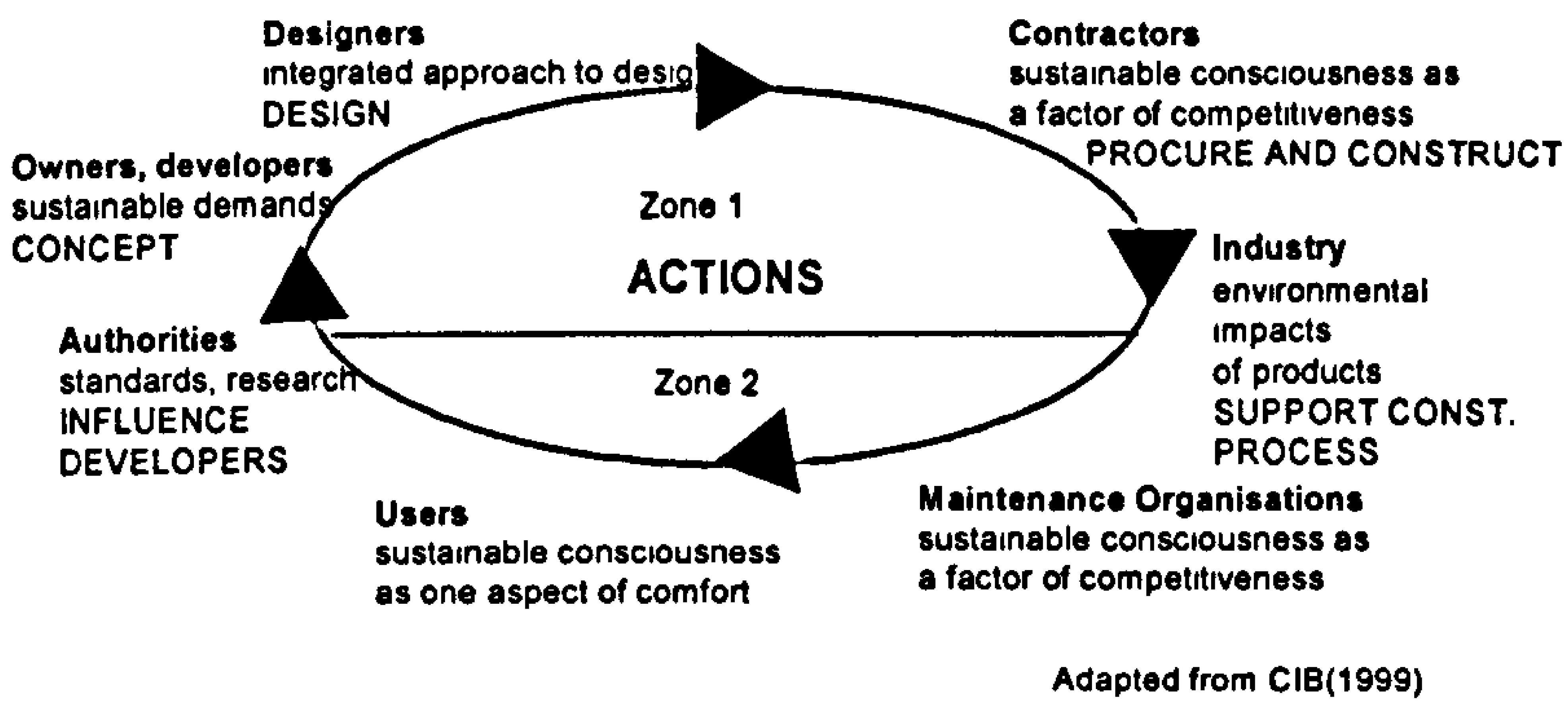


Figure 2.8 Opportunities for implementing sustainable practice in the life of a building

At the design stage the architect, the structural engineer and the services engineer are required and these professionals are very important with regard to informing the client as to how a building project can be undertaken, that incorporates all environmental legislation and environmental best practice. To a large extent the structural engineer is bound by a lack of alternatives there are for structural frames: steel frame structures, insitu reinforced concrete and pre-cast, pre-stressed concrete all involve the use of steel and concrete which are both non eco-friendly materials but there are many environmentally friendly options available to the architect and services engineer.

At the procure and construct phase, the two functions can be carried out separately, for a traditional contract and a quantity surveyor can advise a client on a procurement route that will be the most cost effective for a particular project. However the increased use of the design and build, management contracting and PFI procurement routes, plus greater willingness of clients to adopt partnering arrangements has meant that the traditional role of the quantity surveyor is now being taken over by the contractor. The contractor is also the party that has sole responsibility for ensuring that sustainable construction techniques are utilised during the actual building work.

For these reasons the concentration of this chapter should be on the three professions of architect, building services engineer and construction manager, and their relevant professional bodies. However, as has previously been discussed, to focus on three professions is out of the scope of this research project and as the Chartered Institute of Building educational framework has three functions, construction management, design management and property management that all include building services the focus will be on their educational policy. A brief summary of how other professional bodies have addressed environmental issues is included for initial comparison purposes.

2.4.3 Comparison of the Environmental Content of the Educational Frameworks

The majority of construction education in the UK is monitored, and in most cases controlled by professional bodies covering disciplines such as Architecture, Surveying, Construction Management, Engineering, and Planning.

A summary of the response from the UK's construction-related professional bodies in addressing the sustainability debate is summarised in table 2.4.

Discipline/ professional body	Undergraduate curriculum influence	Sustainability focus
Architecture Royal Institute of British Architects (RIBA) Members: 30000 (RIBA 2005)	Outcome based "Criteria for Validation" in conjunction with departmental accreditation visit	2002 Criteria includes design-specific social, cultural and environmental learning outcomes, and specific skills requirements (RIBA 2002, p5-6)
Construction Management Chartered Institute of Building (CIOB) Members: 40000+ (CIOB 2006)	Requirement to comply with 80% of outcome based *Education Framework*, with accreditation visits	Framework refers to environment aspects and broad social, ethical and cultural issues. Some specific skills requirements relate to sustainability. (CIOB 2005)
Engineering Institution of Civil Engineers (ICE); Members: 80000 (ICE 2006) Institution of Structural Engineers; Members: 20000 (IStructE 2006) Chartered Institution of Services Engineers Members: 17000; (CIBSE 2006)	Curriculum expectations for ICE/CIBSE/IStructE published by 'Joint Board of Moderators', with peer review through departmental visits	Need for sustainable development delivery in degree programmes with detailed lists for knowledge, skills and attitude development published July 2005 (JBM 2005)
Surveying Royal Institution of Chartered Surveyors; Membership 110000 (RICS 2004)	Curriculum expected to broadly support development of surveying competencies.	RICS announces need to address education for sustainability (RICS 2005, p17). No formal requirements.
Planning Royal Town Planning Institute (RTPI); Members 18000+ (RTPI 2006)	2001 Education Policy Statement issues as guidance to universities. Revised 2004 (RTPI 2001; 2004).	Sustainability, social, economic and environmental contexts and development of appropriate knowledge specifically referred to (RTPI 2004, p3, p9).

Table 2.4 Key construction-related professional bodies – input to education for sustainability literacy (Murray and Cotgrave, 2007)

The table demonstrates a mixed response to the Sustainable Development Education Panel (SDE) proposal. Furthermore, a detailed review of the curriculum requirements of the CIOB, CIBSE and the RIBA reveals how they allow for a relatively high level of interpretation. Consequently, universities that have little or no relevant expertise, or intention, to integrate sustainability into the curriculum can get their courses accredited. Clearly, without detailed requirements for embedding sustainability elements in accredited courses, the influence of professional bodies in the UK will be weak and patchy. Nevertheless, the engineering institutions, and to a lesser extent the RTPI, are taking a lead and, over time, may well prove influential and inspirational to other similar bodies.

2.4.4 The Chartered Institute of Building

The CIOB is the leading professional body worldwide for managers in construction (CIOB, 2002). For almost 170 years the institute has pioneered the way in establishing, promoting and maintaining standards of excellence in the construction industry, and now sets the pace on a global scale for the education and professionalism for those who manage the construction of the built environment.

The CIOB has almost 40,000 members working in over 90 countries. They claim to be a dynamic institution, working to a rolling and constantly evolving corporate plan that includes the CIOB educational framework that takes full account of national commitments to lifelong learning programmes and vocational training.

Membership of the professional body is a recognised mark of professional status. As this research project concentrates on the undergraduate curriculum, the route to membership most relevant is the accredited degree route. The Institute accredits undergraduate courses in Universities if all of their criteria are met. Upon graduation of these programmes the graduate will undertake a period of structured professional development, which may include further academic work before becoming accepted as a member. Therefore education and continuous development are stressed as being of major importance.

2.4.5 Review of the Educational Framework

2.4.5.1 Educational Framework 1994

The objective of the framework was to examine the knowledge and understanding required of those preparing to become a chartered builder. The curriculum aimed to provide a vehicle for the acquisition of knowledge and understanding required for membership. It was stated that the framework would provide greater flexibility and precision than previous schemes and was structured as follows: -

- Formation Studies – Level 1
- Core Studies – Level 2
- Professional Studies – level 3

The curriculum needed to be interpreted to take into account the difference between gaining an honours degree and professional study, the latter requiring learning within a professional context i.e. just gaining the degree does not mean automatic entry to the Institute, professional training and suitable experience is also required.

One of the key statements in the framework with regard to the environment is as follows:

'a knowledge of safety, health and welfare, along with maintenance and improvement of the environment is considered to be essential and is inherent and examinable in all subjects in the Education Framework. Similarly information technology and quality management are considered integral to all syllabuses' (CIOB, 1994)

The guidelines are therefore promoting an integrated approach to the teaching of environmental issues as opposed to a fragmented approach, and demonstrate that the CIOB had taken seriously the recommendation of the Toyne Report that all professional institutions should seriously assess the place of environmental issues within those HE courses for which they control or influence the curricula. The Institute promoted the use of options within programmes, as the structure was not intended to create specialists but rather to enable candidates to demonstrate the application of knowledge and experience within appropriate examination settings.

The framework identifies elements of knowledge and skills that are required by students, it was required as part of the accreditation exercise that proposed courses mapped their modules against those of the framework, but a level of interpretation by the universities was also expected as the framework contains a great deal of content.

Each subject area is broken down into 'learning outcomes' and a set of 'range statements' is included to give examples as to how the learning outcome can be achieved. In the 1994 framework there is no learning outcome that relates to sustainable construction or design and no mention of in the range statements.

2.4.5.2 Educational Framework 2002

In 2000 a review of the 1994 framework was initiated by the Education and Membership Board, the objective of the review was to improve the ability of the CIOB to recognise the increasingly broad range of built environment disciplines. In defining the base level of knowledge, and the academic standard of achievement required for the development of professional construction managers, the CIOB has recognised the long term trend from internal institute examination towards the accreditation of relevant university degree courses (CIOB,2002).

The Primary Aims of the new framework were to:

1. Define professional level educational underpinning for those wishing to engage confidently, proficiently and successfully in the general or specialist management of building, construction, production and design management, adaptation, conservation or removal of buildings
2. Support a code of professional conduct and ethical behaviour
3. Meet the expectations of the Quality Assurance Agency National Benchmarks statements for "Building and Surveying"
4. ***Establish the learning experience within the context of construction application, thus enabling the integration of theoretical knowledge and understanding with industrial practice, including health, safety and welfare and environmental sustainability.***
5. Enable the development of critical, analytical, transferable and study skills, which are of practical benefit in the workplace, which promote and enable continuous professional development.

From these broad aims it can be seen that there has been great development in the ideology behind the new framework, and if strictly adhered to should allow for further inclusion of environmental applications in the construction process. All aspects of the building life are now covered in the aims, BUT the aims do not state that all students have to have knowledge of all those aspects, different functions have different specialisms and this will affect the level of concentration on particular aspects of the building life. For example the construction management function does not dictate that there should be any coverage of building maintenance in the programme.

Supporting a code of professional conduct and ethical behaviour is a very broad aim, and could be interpreted in an environmental context but this is not specific.

The changes included in the 2007 revision can be linked to the recommendations of the 2002 second Egan Report where sustainability is referred to in much greater detail than in the previous report. The 2002 educational framework would be influenced by the first report only, where sustainability is scarcely mentioned.

The QAA national benchmark statements that are used as one of the starting points for curriculum design are very broad, necessarily so because they have to be applied to a great many different very specific disciplines, and therefore meeting the expectations of these benchmarks is left very much open to interpretation.

For the purpose of this research project, aim 4 is probably the most important as this reiterates the idea that environmental educational and health and safety should be integrated into the curriculum as opposed to fragmented. The aim appears to rely on industry best practice being translated into the curriculum in the areas of environment and health and safety. There is no evidence in the previously undertaken literature review that industry is undertaking or developing best practice, in fact the majority of research in this area is being undertaken by the universities and it has already been established that there is a problem with communication between academia and the industry.

Aim 5 is a very useful addition to the 1994 model and modernises the framework with regard to teaching, learning and assessment and also should enable students to develop the skills they require to undertake the Professional Development Programme (PDP) upon graduation. It also allows for academic staff to develop teaching and assessment techniques that will allow for the highest levels of environmental learning within the programme, which should ultimately improve environmental behaviour.

The framework also requires the creation of a multi-disciplinary practice base and encourages reflection to enable students to apply current cultural and social values in producing and managing the built environment. This concurs with previous findings of the literature review that indicates that this is good practice for encouraging improved environmental performance in the industry.

The framework is focussed on learning outcomes, and the outcomes are structured in three levels which are progressively encountered:

- Level 1: Principles and Context
- Level 2: Analysis and Application
- Level 3: Synthesis and Evaluation

And at each level there are four components to the programme of study:

- Construction Technology
- The Construction Environment
- Specialism
- Skills

This is a significant change to the 1994 model and, but concurs with the current JMU model. Figure 2.9 illustrates the required balance of components during the learning process.

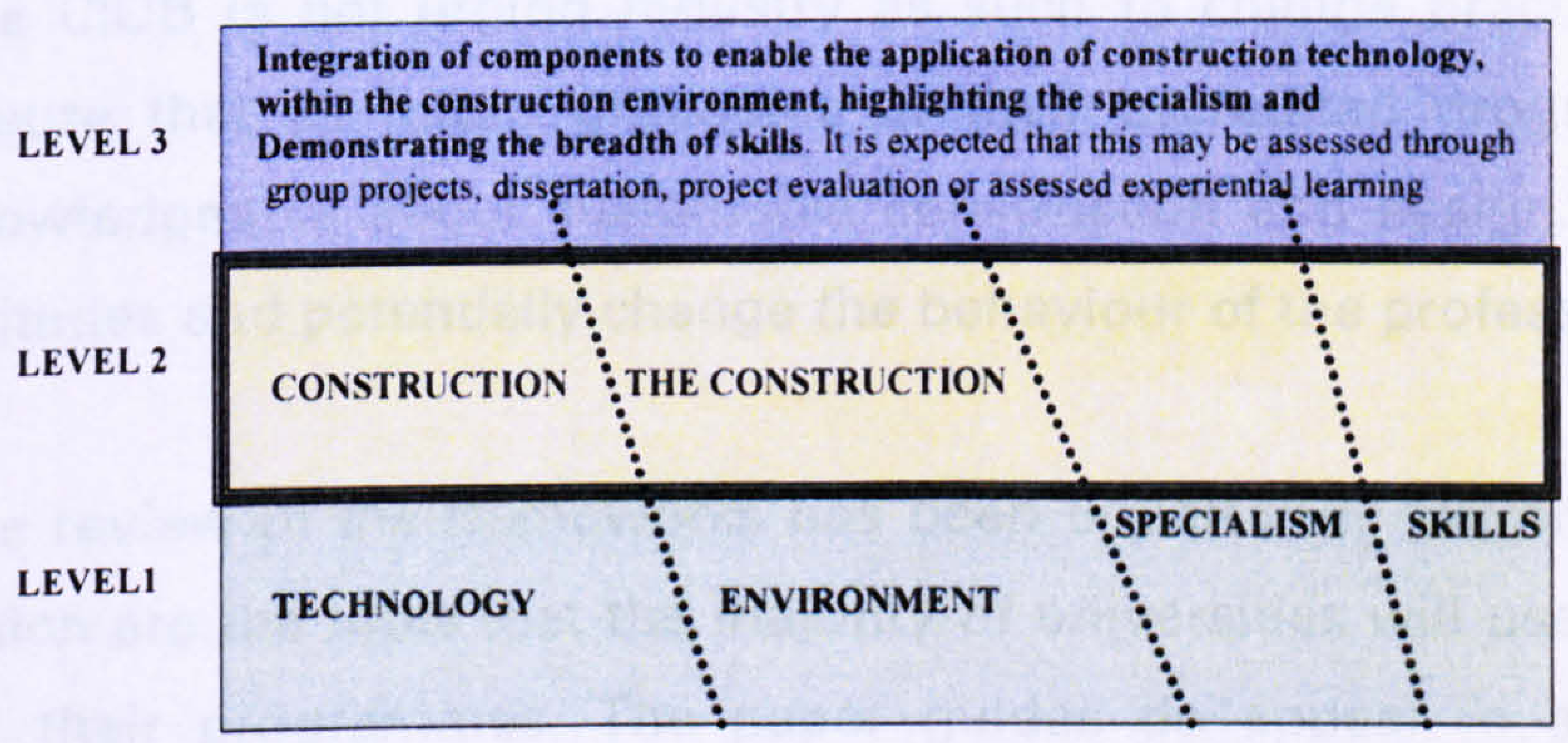


Figure 2.9 CIOB Educational Structure for accredited undergraduate programmes (2002)

Comparison of the aims and range statements in the 2002 model against those of the 1994 model show very little difference. In the 1994 framework there is no learning outcomes that relates to sustainable construction or design and no mention of in the range statements, but in the 2002 model there is still no learning outcome but sustainability is mentioned in the range statements.

2.4.5.3 Educational Framework 2007

A new framework was launched in 2007. There are some minor changes from the 2002 framework, but one significant change. There is now a specific learning outcome related to sustainability:

The student should understand the design and use of sustainable construction including the environmental impact of buildings.

With a subsequent set of range statements:

The integration of sustainable technologies and systems in the building design and production processes. Waste minimisation, control, sorting, closed loop recycling and disposal options.(CIOB,2007)

Unfortunately the data collection for this project does not refer to the 2007 framework as it was produced too late to focus in the methodology. All data relates to the 1994 and 2002 frameworks. However the 2007 version does reflect that the CIOB have identified sustainability as a key issue for educational programmes and supports Wilkinson's theory of bottom up integration to a point. The CIOB is not urging industry as such to change practices, but is trying to ensure that all future graduates of their accredited programmes are suitably knowledgeable about sustainable construction and design. This should change attitudes and potentially change the behaviour of the professionals of the future.

The review of the frameworks has been undertaken entirely from paper guides, which are the tools that the majority of universities will use to develop curricula for their programmes. The paper guides do appear in all three revisions to promote an integrated approach to the delivery of environmental issues in the curriculum. However they can also be interpreted in a way that could lead to a fragmented approach. For example the CIOB educational framework of 1994 clearly states that an integrated approach is required, but the Liverpool JMU Construction Management programme does not adopt this approach and has been accredited twice under the framework.

All the frameworks promote a learning outcomes approach to curriculum development and promote interdisciplinary education to a certain extent whilst maintaining the 'flavour' of the programme. However the level to which this occurs will depend on the culture and structure of the individual university, and to some extent is out of the control of the programme leader.

2.4.6 Summary

The Sustainable Development Education Panel (SDE) set a goal that by 2010 all professional bodies and industry lead bodies should have sustainable development criteria included within their course accreditation requirements. This has clearly been considered in the development of the CIOB educational frameworks long before the target date, indeed it was included in the original CIOB framework in 1994. This clearly identifies that the professional body understand their role and responsibility in the protection of the environment and are attempting to take the lead in curriculum development to promote environmental responsibility.

However it has also been identified from the review that the frameworks allow for a relatively high level of interpretation, and therefore universities that do not have expertise to integrate environmental issues into the curriculum, may still have their courses accredited. If commitment to this aim was total, then the educational frameworks would state clearly how much time is to be spent on considering environmental issues, in which modules, and what form it should take.

It is the author's belief that the professional bodies will not take this approach for the following reasons:

- If there is no flexibility in the frameworks, each university would have to employ staff with identical specialisms and research interests. This is obviously unworkable and the flexibility in the frameworks allows for each institution to add its own 'flavour' to the programme
- Probably more importantly, it has to be remembered that Construction Management and Design Management programmes are **not** Environmental Awareness and Protection programmes. The students undertake vocational degrees that will enable them to gain employment in the construction industry on graduation. They must have knowledge of specific subjects, and have practical and transferable skills if they are going to be of use to an employer. Awareness and understanding of environmental issues will therefore be only one learning outcome of many, and the professional bodies have to design their frameworks based

on the practices that are occurring in the industry at the time of development.

2.5 Environmental education and curriculum design good practice

2.5.1 Introduction

Developing environmental knowledge, skills and understanding is a major task which must involve many parties besides the education sector. However the higher education sector has an indispensable role to play by providing:

- Specialist courses leading to specifically environmental qualifications
- Updating courses for those already in the workforce.
- Environmental education for all students, whatever their specialist subjects of study (DFE, 1993).

It has been identified earlier that some of the barriers preventing the construction industry accepting the need for more sustainable construction on a global level include human resources lack of understanding of environmental issues, lack of environmental education of the professionals in the industry and research findings generated by academia being too theoretical and not communicated to the industry in a way that will enable the findings to be accepted. (Edwards, 1999). Edwards (2005) identifies further issues that have hampered progress in the inclusion and success of incorporating environmental and sustainability issues in the Built Environment curriculum.

As was discussed in the previous section some professional bodies have only just started to reflect the environmental debate in their educational frameworks and Edwards states that professional bodies have a big impact on the priority awarded to sustainability in higher education curriculum. But he proposes that it would be easier to foster mutual understanding and interdisciplinary teaching if all the professional bodies could agree a core set of environmental values and principles. He also identifies that where sustainable construction and design are taught, there appears to be little correspondence between knowledge acquisition via lectures, and knowledge application via projects.

Referring to the Toyne Report (DFE, 1992) he states that progress is slow in addressing the recommendations made in the report, especially that building developments on university campuses rarely seek to exposes students, and staff, to the reality of sustainable design and good sustainable management. Without a

triangulation between teaching, research and development the built environment student cannot be blamed for not taking sustainability seriously.
Finally he states that initiatives from individual professional bodies, encouragement from government and the broad agenda set out by the Toyne Report, have failed to influence the wider culture of education for the construction and design professional.

The aim of this section is to develop an understanding of the form that environmental education takes, how educational approaches can be developed and the impacts that they could have.

2.5.2 The Development of Environmental Education

2.5.2.1 Defining Environmental Education

Initially an understanding of the term Environmental Education is required. Huckle(1993) defines Environmental Education by three approaches:

1. Education for environmental management and control-which predominantly serves the human technical interest, is based upon the empirical-analytical science, and coheres most closely with the notion of education *about* the environment.
2. Education for environmental awareness and interpretation, which predominantly serves the practical human interest, is based upon interpretive science, and coheres most closely with the notion of education *through* the environment.
3. Education for sustainability, which predominantly serves the critical human interest, is based upon critical science, and coheres most closely with the notion of education *for* the environment

Huckle (1993) believes there is an overwhelming bias towards approach 1 and that this is the wrong approach as material is generally delivered in a didactic mode and is delivered in one subject. He believes that sustainability should be the core theme that runs through the curriculum if approach 3 is to be achieved, which in his opinion would be the most effective. In his definitions of environmental education he is determining the importance of the teacher in achieving environmental awareness, and this importance is reiterated by

Brundtland (1991) who believes that teachers play a very important role in the transition between generations, of the knowledge from one generation to the next. Consciousness raising is vital for change and teachers can convey to students a sense of respect and responsibility for nature and for the global environment.

Disinger and Monroe (1994) believe that environmental education is a process aimed at developing a world population that is aware of and concerned about the total environment and its associated problems, and which has the knowledge, attitudes, motivations, commitments and skills to work individually and collectively toward a solution of current problems and the prevention of new ones. Their belief is therefore that Environmental Education needs to be global if real changes are to be seen.

Sterling and the EDET Group (1992), after summarising the deliberations of environmental educators from many countries, believed that education for sustainability is a process that is relevant to all people and that, like sustainable development itself; it is a process rather than a fixed goal. It may precede -and it will always accompany-the building of relationships between individuals, groups and their environment. All people are capable of being educators and learners in the pursuit of sustainability. They argued that education for sustainability is a process which:

- Enables people to understand the interdependencies of all life on this planet and the repercussions that their actions and decisions may have both now and in the future on resources, on the global community as well as their local one and on the total environment.
- Increases people's awareness of the economic, political, social and cultural, technological and environmental forces which foster or impede sustainable development
- Develops people's awareness, competence, attitudes and values, enabling them to be effectively involved in sustainable development at local, national and international level, and helps them to work towards a more equitable and sustainable future. In particular, it enables people to integrate environmental and economic decision-making.

- Affirms the validity of the different approaches contributed by environmental education, and development education and the need for further development and integration of the concepts of sustainability in these and other related cross-disciplinary educational approaches, as well as in established disciplines.

Ballantyne et al (2006) claim that environmental education aims to foster public awareness and concern about environmental issues, problems and solutions by providing people with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to investigate issues, solve problems and protect and improve the environment. Interestingly they argue that young people are the people that the focus should rest on because they can act as a catalyst of further environmental communication and learning beyond their place of study. They can educate their elders through intergenerational influence as they do with many other things such as the use of computers, mobile phones etc.

It can be seen from these factors that to achieve environmental education in its purest sense would be a complex and demanding prospect, however it must be an aim for all education providers if the environmental behaviour of the total world population is to change. However for the purpose of the research project a workable definition of education for sustainability in the context of the study needed to be established. The following definition will be used, based on the findings and recommendations of Sterling (1992) and Huckle (1993).

'Education for sustainability must include developing people's understanding of the repercussions locally and globally in the future if sustainability is not addressed, increase people's awareness and knowledge of environmental issues, and change attitudes to improve environmental behaviour through the facilitation of the integration of environmental and economic decision making. Education for sustainability needs to be approached with the notion of education for the environment.'

Ultimately we need to believe that bringing together the understanding, intelligence, compassion, and concern for one's descendants, that nearly every human being is capable of demonstrating, will ultimately lead to a vision of sustainability as the only viable future (Bassey , 2002).

2.5.2.2. Developments in Environmental Education

In 1993 Fien and Trainer asked the questions " How do we get from here to there?" " How can we-as individuals parents, teachers, academics, schools, universities, communities, nations and peoples – help effect the transition from present patterns of unsustainable development to ones which are based upon the principles of social justice and democracy and which respect ecological laws and limits?"

They believed that the subject of Environmental Education was a major talking point, but that progress of any meaningful sort, was a long way from being a reality. Sterling (1992) also expressed concern at the lack of progress by identifying that the calibre and extent of current debate on the interface between environmental survival and the role of education is disappointing. Whether education as a whole can be bold enough to develop an adequate response, on a scale commensurate with the issues that have to be addressed over the next decade, remains a crucial question. It is now fifteen years since this statement was made and as later research has concluded, slow progress has indeed been made.

However, Leal Filho (1996) was optimistic that generally the impetus to provide environmental education is progressing well in schools, but it could be better. Fien and Rawling (1996) concurred with this and believed that the reason why environmental education had not become more prevalent is the current status of environmental education in teacher education, which remains at an unsatisfactory level and therefore in schools' environmental education is still at unsatisfactory levels. This could be similarly true in the higher education sector, because if academic research interests, which form the basis of staff development in universities, are not in this area then inclusion of environmental issues in higher education programmes may be limited.

The main focus of the research undertaken by Sterling(1992), Huckle (1993), Fien and Trainer (1993), Disinger and Monroe (1994) and Leal Filho (1996) was on school children as opposed to University students, but it is nevertheless relevant as pre-university education is very important in developing attitudes, and many of their findings can be applied to tertiary education. They were looking at the 'bigger picture' of environmental education which looks at the entire education of children, and therefore identify it as the responsibility of educators at all levels (primary, secondary and FHE) to become educated in these issues and then pass on that knowledge to their students.

2.5.3 The Aims and Importance of Environmental Education and Research

2.5.3.1 Education

Many writers have determined that the main aim of environmental education is to change attitudes that will in turn change behaviour. As long ago as 1976 Ramsey and Rickson identified that it has long been known that the basis for many environmental problems and issues is irresponsible behaviour, and without a doubt one of the most important influences on behaviour is attitude. Campbell Bradley et al (1999) stress the need for trying to change young people's environmental attitudes because young people ultimately will be affected by, and will need to provide, solutions to environmental problems arising from present day actions. As future policymakers, the youth of today will be responsible for 'fixing' the environment and they will be the ones who must be persuaded to adopt and pay the costs of future environmental policies.

Therefore it appears that effective environmental education, which changes the attitudes of young people is crucial. The research of Campbell Bradley et al (1999) showed that environmental knowledge improved significantly after an intensive ten day environmental science course, but although environmental attitude did improve the increase was not significant. This illustrates that factors other than formal education such as background, parents jobs etc. can influence attitude. However the findings do demonstrate a need for formal education programmes and educational interventions that are supported by Zelezney (1999).

Zelezney (1999) defines educational interventions as planned strategies that provide information and/or training to modify or achieve a predicted pro-environmental outcome. The results of her research found that ALL classroom intervention studies reported improved pro-environmental behaviour, and that interventions in non traditional settings less than 50% reported any improvement. (Non-traditional settings included the use of posters to disseminate information, informal workshops etc.).

The Toyne Report (1993) concluded that as education seeks to lead opinion, it will do so more effectively if it keeps in mind the distinctive nature of it's mission, which is first and foremost to improve it's students' understanding. Their concern may be well awakened as a result; but it must be a properly informed concern. This does not necessarily mean treating the environment as a purely scientific issue, but does mean that the respective roles of science and ethics need to be distinguished, and the complexities of each need to be acknowledged. Failure to do this may lead to an 'environmentalism' which, by depicting possibilities as certainties, can only discredit itself in the long run and feed the complacency which it seeks to dispel.

McKeown-Ice and Dendinger (2000) have identified the fact that scientific knowledge and political intervention will not solve the environmental problem on their own, thus implying that something additional is required to change behaviour. As has already been discussed, behaviour changes can only occur if attitudes change and this can be achieved through education, and as Fien (1997) identifies, environmental education can play a key role by creating awareness, and changing people's values, skills and behaviour.

This idea was initially supported by Bruvold (1973) and O'Riordan (1976) who believed that education leads to greater awareness and attitude change, which ultimately improves environmental behaviour. Although there are sceptics, Gardner and Stern (1996) reported from their research that although education was indeed effective in changing attitudes by actively involving participants, the scope may be limited.

More recently Tikka et al (2000) have suggested that the environmental crisis is based on people's behaviour and their patterns of thought, and can be improved by changing this behaviour and patterns of thought rather than using biological or technical interventions. Furthermore the over emphasis on political, socio-economic and technical factors has resulted in failed attempts to preserve the environment therefore emphasising the impact that education could have.

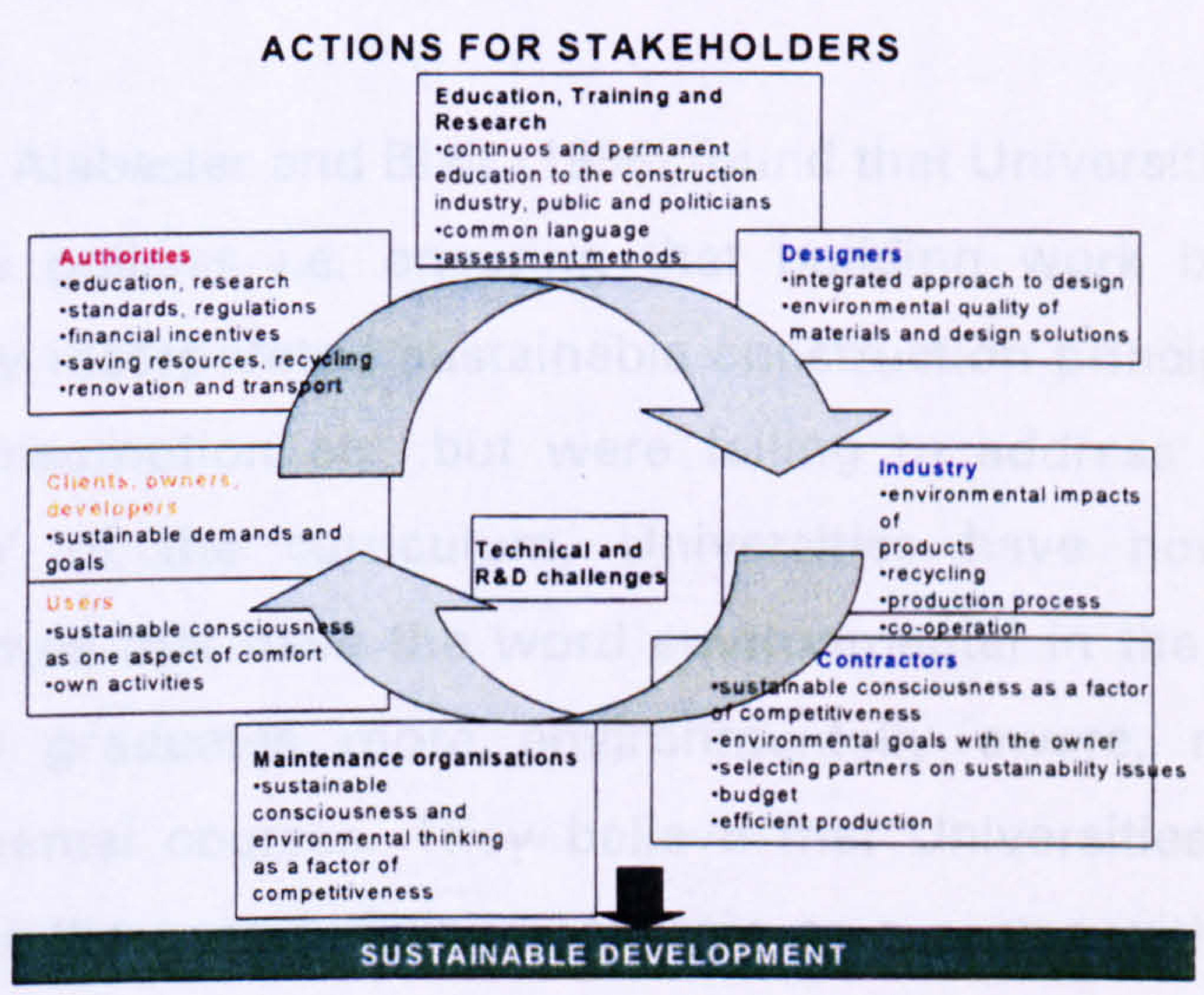
The importance of introducing environmental elements into the curriculum can therefore be seen as an effective way of transferring knowledge, which should in turn improve attitudes that will lead to improvements in environmental behaviour. Graham (2000) believes that it is crucial that building professionals not only participate in the creation of projects that have low environmental impact, but equally it is important that they learn to conceive, nurture, promote and facilitate the kind of paradigm changes seen as necessary to create a sustainable society, thus stressing that pedagogic approaches to teaching may not be the best tool, and also the importance on education. However there are limitations as to what education can achieve on it's own, for as Jucker (2002) believes, if we do not do everything we can to transform our political, economic and social systems into more sustainable structures, we might as well forget the educational part.

2.5.3.2 Research

Many writers identify the importance of the role of universities in providing students with environmental knowledge that they can further disseminate. Gouldson and Roberts (2000) believe that an important element in creating a sustainable future is to direct research, development and innovation towards better environmental practices. Universities are the institutions that have the expertise to undertake this research, and then feed this into the curriculum. However as Valence (2000) identifies, many environmentalists/researchers seek ideal solutions to problems and there is already a great deal of literature which details these solutions. Governments have to balance these solutions with economic factors in order to gain global acceptance.

Gann (2001) states that the relationship between the production and use of new ideas and changes in the rate of absorption of research outputs can be analysed from the perspective of a radical shift in the production of knowledge. Gibbons et al (1994) call this a shift from mode 1 to mode 2. Traditional knowledge production systems were based on a clear demarcation between the public and private sectors. Universities carried out research which they believed was in the long term public interest of adding to the 'body of knowledge' within a particular discipline, and much of this knowledge was produced primarily for the use of other academics. Quality was controlled within defined frameworks by other academics and it was believed that ideas first developed by academics found their way into industry through mechanisms such as university curriculum (education of students).

Gibbons et al (1994) claim that mode 2 is now emerging because distinctions between public and private knowledge are blurring, and universities are involved in consultancy which has meant that industry has become a significant participant in research and training. Gann (2000) believes that this is not the case in construction, but that it needs to be. He goes further in identifying that the quality of construction research needs to be considered in the context of its possible applications in industry and there needs to be greater collaboration between academia and industry. The education sector has been identified as being one of the main stakeholders in helping to achieve sustainable development from education, training and research perspectives as shown in figure 2.10. The sector needs to provide the right type of education on an ongoing basis and ensure that sustainable construction becomes an easily understandable concept.



Source: CIB(1999)

Figure 2.10 Stakeholders in environmental education

2.5.4 The need for environmental education in the Higher Education sector

There is a general feeling that the principles of environmental education are understood, but that the practice is patchy and the approach may need to change. Didactic teaching approaches in one subject only will improve student knowledge on environmental issues, but not necessarily attitudes on a scale that will enable real changes to occur. The writers quoted have all concentrated predominantly on primary and secondary education, and believe that the environment should be a core theme running through the curriculum. This research project focuses specifically on Higher Education and as Alabaster and Blair (1996) suggest, it is FHE institutions that should be centres of innovation and leadership in how to improve environmental responsibility, and therefore should take the lead even before government intervention. The Toyne Report (1993) identified that FHE has an important part to play in developing the environmental understanding of students whose courses are not specifically 'environmental' in focus, but whose graduates would be responsible for making decisions that could have an effect on the environment

However Alabaster and Blair (1996) found that Universities concentrated more on corporate policies i.e. ensuring that building work being undertaken by the University incorporated sustainable construction principles, reducing paper and water consumption etc. but were failing to address the major issue, that is 'greening' of the curriculum. Universities have now validated many new programmes that have the word environmental in the title but the aim was to make all graduates more environmentally aware, not just those studying environmental courses. They believe that Universities should exhibit tangible signs that they are fulfilling their role as a sector with a deep and permanent sense of social responsibility to their own workforce, the local region in which they are situated and to the (inter) national community. In simple terms they should be leading the way, but are not doing this. They also advocated that the Universities do not practice what they preach, i.e. they run environmental courses but they don't practice environmental awareness.

Howard et al. (2000) also recognise that H.E. has extensive responsibility for mounting and supporting courses related to the environment, but its strategic suggestions are limited. They suggest that the tertiary sector should establish departments or centres focused on ESD (Ecologically Sustainable Development), provide students with flexible learning to promote multi disciplinary studies, and promote a whole institution approach to environmental practice.

To a certain extent these practices have been adopted by many HEIs, but these approaches need to be adopted in totality, which is not the case currently. One of the aims of this research project is to make recommendations as to how this problem can be overcome, specifically in construction management programmes.

Sterling and the EDET Group (1992) viewed the inclusion of sustainability in the curriculum of all undergraduate programmes as essential but it is possibly of the most importance to those students studying programmes that will ultimately proceed into employment in industries where their decision making will have a major impact on the environment. Indeed Sterling (1992) and Huckle (1993) highlighted that universities validated 'Environmental' programmes but there are not enough graduates from these programmes and they do not tend to proceed to employment in industries that have poor environmental records.

Coppola (1999) concluded from his research that specialized environmental programmes reach only a minority of undergraduates and therefore their influence is limited. It is the graduates of vocational degree programmes, such as those concerned with the production of the built environment, who need to be more aware of the issues of sustainability, because they will then work in these industries and potentially have a far reaching impact.

Woolley and Kimmins (2000) support this idea by identifying that although the general public has become more aware of environmental issues which has led to an increase in the purchase of organic food, recycled toilet paper, eco-friendly detergent, bio-degradable nappies etc., they have developed less awareness of the impact that their homes have on the environment which is far greater than using non-recycled toilet roll! There is therefore the need to educate those who have the most impact on the built environment-the professionals who steer the industry from conception through to design and construction phase. This specialisation does not occur in schools, but in higher education.

The argument is that the only point in educating the majority in environmental issues, is so that they will become informed clients who will place environmental issues at the top of their requirement lists as opposed to the traditional requirement of low cost. It is these clients that need to be targeted when they are procuring construction work, with regard to utilising sustainable construction practices and the employees of these organisations are usually graduates of the Higher Education sector. Orr (1992) supports this idea by stating that it is the university sector that will make the greatest immediate impact on sustainability. It has the opportunity to shape the leaders of tomorrow, it is widely respected and capable of setting an example to the wider society. Additionally it has a broad impact on policy and technology.

The generalist graduates that will ultimately manage organisations will tend to employ architects and other designers when they have decided to develop new property and then use a traditional procurement route to choose a contractor. It can therefore be seen that if the designers and constructors understand the benefits of utilising sustainable materials and systems, and employing sustainable working practices, they will be the people that can ultimately persuade clients that a slightly higher financial cost could lead to a substantial reduction in cost to the environment. This reiterates the necessity of targeting environmental education to these students.

Even Fien and Trainer (1993) who are two of the greatest advocates of the introduction of global environmental education believe that it is an unrealistic expectation of schools and teachers to change the ways that the global patterns of development occur, just by including in the curriculum the issues of global environmental problems, since it has to be assumed that there are no problems with education systems and the bringing about of social change. Therefore to educate people en masse to appreciate the concepts of sustainability may be difficult to achieve in the short term and further destruction of our environment is occurring on a daily basis. However to educate construction undergraduates to appreciate the importance of sustainability is relatively easy to achieve in the short term and they could potentially have a real impact in the world in the short term.

The importance of education of built environment students in HE becoming environmentally focussed towards and concentrated on improvements to environmental performance of the industry is clearly illustrated by Wemmenhove and de Groot (2001), who emphasise that it is essential that students are trained on how to communicate with the non-academic society so that they can advise clients and customers on making informed choices of building products and processes that may not be the cheapest options, thus influencing design. Langston and Dingk (2001) go further and identify that proper training of site operatives through effective supervision is imperative if sustainable practices in the building process are to be fully utilised.

The people who will manage this training are the graduate construction managers and therefore their knowledge must be comprehensive. With these two statements it can be seen that education of the designers and construction managers is of the utmost importance and it is the universities' responsibility to undertake this education.

2.5.5 Barriers that prevent sustainability being included in the curriculum

The importance of environmental education and the need for targeting those in the HE sector, who will have a responsibility for decision making that can affect the environment is realised by the many parties that are involved in curriculum development.

However there are many barriers that prevent this from being the case, which can be broken down into five categories:

2.5.5.1 The organisation and funding of UK Universities

Dulaimi (1995) and Wilkinson (1997) believe that the structure and funding of UK HEIs are the main factors that hinder change, but also that change is imperative. The barriers therefore need to be bypassed by HE in order to facilitate adaptation of the curricula. These beliefs were reiterated by Ali Khan (1996) who found that there was considerable indifference to the DFE (1993) report, which recommended that the Higher Education Funding Council for England (HEFCE) should take steps to encourage and reward the adoption of sound environmental practices in institutions. He found that the vast majority had not developed environmental policies and that hardly any progress had been made with regard to curriculum greening. This was also evidenced by the Forum for the Future Audit of 1998, which was an audit of Higher Education Engineering curricula.

Alabaster and Blair (1996) identified that universities should exhibit tangible signs that they are fulfilling their role as a sector with a permanent sense of social responsibility to the local and the global issue of sustainability, but lack of funding and rigid educational framework structures prevent this.

2.5.5.2. Academic indifference and approach to teaching and assessment

Fien and Rawling (1996) found in their research that the professional development of environmental educators as agents of change who have central roles to play in helping create the broad social context necessary for ecologically sustainable development, is essential. However Alabaster and Blair (1996) found in their research that academic staff are often ideologically resistant to curriculum changes that emanate from outside the bounds of their discipline. Greening is yet another initiative to accommodate in a workplace that has been flooded with others and is subject to major changes in terms of teaching and learning, structures and institutional reforms. Some academics were trained in disciplines before the interdisciplinary environmental agenda assumed such importance. Lack of staff confidence, time and training are real stumbling blocks to greening any curriculum.

They proposed that the solutions to these problems can be derived from other initiatives, for example IT, targeted staff development, updating courses, time allocation, funding and the legitimising of research in this field. An interesting comparison is the extent to which IT has been adopted by the sector, which contradicts the idea of academic indifference. IT has been adopted both by Institutions centrally for control of admissions and for storage of student progression information etc. and also by academic staff who use software packages to enhance teaching and learning, communicate more and more with students via e-mail and are also embracing the use of virtual learning environment software to improve delivery of material. Although a great deal of academic staff development time, either through structured programmes or personally directed initiatives, has been expended in developing these IT skills, academics in the main have seen the huge benefits of these developments.

However when trying to establish a reason why this particular development has been adopted it could be cynically argued that the use of IT aids the lecturer, for example by reducing the time it takes to update lecture notes, as opposed to learning and changing new material which takes much longer. Time is obviously a major issue, and the Toyne Report(1993) identified this as being a barrier that prevents academic staff development and recommended that all institutions involved in environment related updating should explore with their industrial and other clients the scope for staff secondments.

One of the major concerns generally in UK HEIs, and one that is clearly identified by Wemmenhove and de Groot (2001) through their research based in Tanzania, is that student assessments may consist only of extensive reproduction of theory. It is especially important that this is considered when designing a curriculum, which in effect has to change the paradigm through which the student views the world. Reproducing rote learned facts would not achieve the shift required, which illustrates the need for all aspects of the curriculum to be addressed, the topics taught, the method of teaching and perhaps most importantly the way it is assessed. It is not suggested that UK universities adopt this approach to the whole curriculum, but there may be an excessive bias to this form of assessment in some subject areas, especially those that are accredited by professional bodies that have strict policies regarding the number of formal closed book examinations to be included in a programme.

Van Woerden (2000) quoted by Wemmenhove and de Groot, stated that from discussions undertaken with students, young professionals and government officials he had identified that there was a need for a more student-oriented educational approach, giving the student more responsibility for his or her own learning process, as opposed to the current transfer-of- knowledge style. He also states, probably unfairly to the majority, that university staff are generally uninterested in education, and therefore show little enthusiasm for reform, but prefer to concentrate on their personal research.

Simons (1996) advocates the use of the case-study approach to teaching sustainability because of its capacity for understanding complexity in particular contexts. This is reiterated by Perdan et al (2000) who have identified that more work needs to be done to develop, organise and consolidate case studies and to include them in all inclusive teaching and learning resources.

Due to the nature of sustainability and the need to change views/opinions of the student it is essential to adopt lifelong learning principles and reflective learning for the education of professionals regarding sustainability. All of these issues would need to be addressed by academics who may find them difficult to achieve.

2.5.5.3 The curriculum

If a common national approach to the teaching of environmental and sustainability issues is to be achieved, then uniformity of the curriculum needs to be addressed. The construction industry professional bodies are responsible in some instances for curriculum design, but in other instances that is left largely to the University whilst the professional body only concentrates on the rules and regulations. It is this flexibility that creates non-uniformity.

For example Edwards (1999) identifies the Construction Products Directive (89/106/EEC) as one of the most important EC directives for the architect. The directive requires that any construction product or components offered for sale must allow the building works to satisfy the requirements of mechanical resistance and safety, safety in case of fire, hygiene, health and environment, safety in use, protection against noise, energy economy and heat retention. This directive, if it is so important, should be included in every curriculum but it is doubtful that this is the case. Edwards also explains the role of the Architects Directive (85/384/EEC) in establishing a common basis across Europe for architectural qualifications and training, which will go some way to achieve uniformity in architecture education, but there is no such directive for construction education across the board.

2.5.5.4. Student backgrounds

Tikka et al (2000) aimed to identify student attitudes to the environment by comparing students from a variety of educational establishments, their objective was to determine whether there were significant connections between a) students' attitudes to the environment, b) their willingness to participate in environment related activities, and c) their knowledge of current environmental problems. They realised that education is only one of the factors that contribute to learning but tried to discover whether the educational background and place of education affected attitudes and knowledge.

Their research found that the students with the worst attitude to the environment were engineering (electrical and mechanical) students and vocational (courses sponsored by industry) school students, which is significant as these are the students who are most likely to go on to work in industries that have the most impact on the environment. Another significant finding was that in all three areas women fared much better than men, which does not bode well for industries that are still male dominated such as construction. Gigliotti (1992) explained the negative attitudes of engineering students as being due to the fact that students were unwilling to make personal sacrifices in favour of the environment because they trusted the capability of technology to solve environmental problems. Therefore student backgrounds could be a major barrier to preventing changes in attitude.

2.5.5.5 Lack of communication between industry and academia

One major problem preventing sustainability as a concept in the built environment gaining acceptance, is the reluctance of industry to afford it more consideration than it is receiving at the moment.

Leal Filho (1999) believes that sustainability would be better accepted as a concept by industry if the link between the theory and practice of sustainability were fostered better i.e. industry and academia work together to develop workable systems, specific issues such as reduction of waste are concentrated on rather than keep debating the 'wider' meanings of sustainability, and the value of sustainability was better disseminated, again this can be achieved through a partnership of academia and industry.

Indeed the DFE(1993) report stated the need for government to seek ways and means of encouraging closer dialogue between FHE and employers in the greening of curriculum, as it identified that there is a problem with communication between the parties.

As has already been stated, one of the problems with university generated research is the methods used for assessing the quality of that research. Academics are judged by their peers and success usually requires an in depth knowledge of particular methods based on scientific disciplinary practices.

However, academics in construction research may also be expected to deliver results of value to industrial user groups where real life problems are identified that cut across disciplinary boundaries. The need for methodological rigour combined with interdisciplinary scope creates a challenging research environment that does not exist at the moment.

Gann (2001) identifies that young construction researchers who have a great deal of potential are lured away from the universities by the higher salaries they can enjoy in industry, thus reducing new approaches to research being adopted. If these students were employed by 'learning organisations' that would embrace their talents and encourage research that was totally industry based then this would improve the flow of knowledge into these organisations, but unfortunately these are few and far between in the construction industry.

As Gann has found through his research, in the UK of the 160,000 contractors, fewer than 20,000 employ people with a technical or professional qualification. Of those only around 2,000 firms employ five or more people with such qualifications, and the total the number of firms that have the expertise in house to make use of new ideas is around 1% of the total number of construction firms. The result of these problems is a barrier that reduces the amount of research being undertaken by the universities that is of use to the industry, and any that is of use being poorly communicated.

2.5.6 Strategies for improving student learning and attitude to environmental issues

The importance of environmental education, the reasons why environmental education should be targeted to those students who will ultimately be responsible for making environmentally responsible decisions and the barriers that prevent sustainability being the top priority in the HE curriculum have been identified. Strategies for improving student learning and attitude to environmental issues now need to be defined.

These strategies can be categorised under four main headings:

1) targeting those students who will be employed in a decision making capacity that can affect the environment
2) integrating environmental issues into the curriculum and recognising the importance of that element of the curriculum
3) reviewing approaches to teaching and learning
4) establishing partnerships between industry, academia and the research community in order to develop workable practices.

2.5.6.1 Targetting students

Perdan et al (2000) were involved in the teaching of engineers at doctorate level at the University of Surrey. The main aim of the Engineering Doctorate that is offered by the University is that the graduates will be environmental managers who will make a difference. They will be first rate engineers and applied scientists, but will also be required to have a broad understanding of the social and philosophical context in which they work. This is an excellent initiative but the number of people who will study for this programme will be small and therefore their influence will not be far reaching. If all Construction Management and Architecture courses had this as the main aim, then that could make a difference.

2.5.6.2 Integrating environmental issues into the curriculum

Dorweiler and Yakhou (1998) in their research identified that although students in traditional engineering disciplines may sense the professional potential of environmental understanding, they may need the further inducement of academic recognition. Although attitudes may not be altered that much by education, it is still very important in order to pass on the available knowledge to enable students to develop an informed attitude. In the United States degrees are structured with a major and minor element, it is therefore possible for the students to major in engineering and minor in, say, environmental management, which will give academic recognition. In the UK the structure of undergraduate degrees in built environment disciplines does not allow generally for 'majoring' and 'minoring' and therefore alternative ways of including and embedding environmental issues needs to be addressed.

Perdan et al (2000) recommend that what is required is that the specification related to the area of sustainable development is expressed in terms of learning outcomes which describe assessable changes in knowledge and skills development and behaviour that the programmes, modules and learning materials should bring about. They also firmly believe that to achieve completeness in the teaching of sustainability all modules and materials used for teaching must include technical analysis, economic evaluation AND environmental and social considerations. This model is far more suited to the UK Higher Education structure and especially to the curriculum for built environment programmes.

The CIB (1999) believe that there is widespread consensus that education and training should be extensively utilised to make sustainable development concepts well known and accepted by people. The need for a large concerted programme of awareness raising is striking. They state that programmes should aim, not only at all the participants in the construction process, but also at the public, politicians and government administrators. And further that sustainable building principles should be incorporated into the curricula of training courses for architects, designers and construction engineers, not only initial training i.e. 1st degree, but also in Continuing Professional Development.

Perdan et al (2000) identify that to develop deep and real understanding of the issues surrounding sustainability the following learning outcomes need to be addressed in the curriculum. Students will develop:-

- An understanding of the interdependence of major systems
- An understanding of the needs and rights of future generations
- An understanding of the value of diversity
- An appreciation for the need for precaution
- An appreciation of the Earth's carrying capacity

Any curriculum redesign should therefore seek to address these outcomes.

2.5.6.3 Reviewing approaches to teaching and learning

CIB (1999) have identified that interdisciplinary training in design and construction processes should be facilitated to the greatest extent possible and best practice disseminated. They are therefore advocating that although there are specific responsibilities and skills required by all the parties in the construction process, there is a real need for students on undergraduate programmes to have exposure to other undergraduates to learn about the elements of each other's professions that can impact on their work.

Williams (2004) states that built environment departments often group students together by discipline which reinforces the 'silo' mentality experienced within some parts of the industry. Exposure to other disciplines throughout a programme of study helps break down these barriers and raise awareness of discipline specific problems. Therefore interdisciplinary learning should be advocated in built environment departments.

Fien and Rawling (1996) have identified that a move from traditional classroom theories that stress academic knowledge, didactic teaching and classroom order are a barrier preventing a move to the more adult learning approaches necessary to create changes in attitude. Professional development studies in environmental education need to be participatory and practice based. Working actively with other practitioners to resolve tensions and contradiction can provide the personal reflection necessary for meaningful changes in professional practices in environmental education. And further that professional development studies in environmental education must be collaborative because working collaboratively is usually more productive than individual efforts. This is particularly relevant to construction education as the adversarial nature of the industry, which may be mirrored in educational establishments has been much criticised by Latham (1994) etc.

The use of group projects is a way of facilitating this approach and if reflective learning is also encouraged then this will be enhanced further. Fien (1997) supports the idea and realises the benefit of reflective learning in sustainable development and identifies that if interdisciplinary, life-long practical experiences are critical, effective education for sustainability cannot be achieved without this approach being utilised. Therefore if students do not reflect on this learning it will not lead to a change in values, attitudes and behaviour.

Moon (1999) suggests the following schema to guide reflective activity in professional development towards improvement of professional practice

Phase 1-Develop awareness of the nature of current practice (level 1)
Phase 2-Clarify the new learning and how it relates to current understanding (level 2)
Phase 3-Integrate new learning and current practice (industrial placement)
Phase 4-Anticipate or imagine the nature of improved practice (level 3)

Reflective practice involves using ethical and contextual considerations in professional decision making rather than making such decisions on the basis of habitat, intuition, impulse and tradition. Reflective action is deliberative action that results from the active and thoughtful consideration of specific beliefs and knowledge in relation to past and future consequences.

2.5.6.4 Links between academia and industry

Yuan (2001) identifies the extent to which higher education impacts on society, through the sustainable development research which has begun to influence policy agendas of government and the private sector. He also states that greater interaction between HEIs and industry can foster the kind of sustainable economic development relevant to today's economies. It is therefore essential that any curriculum developments undertaken are done so in conjunction with advice from industry partners, either companies or professional bodies.

Salter (1999) holds the view that industry involvement in curriculum design is important because it 'keeps it real'. His view is that the purpose of "curriculum greening" is not to promulgate extreme views of sustainability but rather to be pragmatic and to provide a balanced view of the issues. He states:

'We would fail in our mission as educators if we did not train our students to current, industry, standards but we should always make our students aware of alternatives to these practices.'

2.5.7 Curriculum Design and Development

2.5.7.1 Approaches to Curriculum Design and Development

Wolfe (2001) asks the question "Is there a "best" approach to incorporating environmental learning into the curriculum?" and answers it by saying no. Courses can be designed around "content inputs" or "learning outcomes", and learning outcomes can be modular specific, level specific and/or programme specific. However it is sometimes easy to fall into the trap of assuming the programme has been designed around learning outcomes when in fact the learning outcomes have been written based on the content input. The learning outcomes will be written based on staff expertise as opposed to what you really want as an outcome. The outcome that is required is that students will be environmentally literate on completion of their studies, not just knowledgeable in some aspects of the environment where staff expertise exists.

Huack(1998b), Auchey et al.(2000) and Wolfe(2001) all believe that a learning outcomes approach to curriculum design is the most suitable approach, and this is supported by the Chartered Institute of Building (CIOB, 2002 and 2007) educational frameworks that are designed using a learning outcomes approach.

Auchey at al. (2000) found that by using a Learning Outcomes Template in the design of a curriculum it can:

- Guide the process of evaluation and change so we do dot have change for change sake, but true continuous quality curriculum development

- Precipitate the development of progressively more difficult problem solving skills at the appropriate levels of curriculum progression
- Overcome the "If it ain't broke don't fix it" resistance that some faculties might have
- Recognise and capitalise on increasing skill levels to teach management, leadership and team building skills
- Provide a guide for improving the combined effectiveness of faculty team teaching effort
- Help students understand the natural process of information acquisition throughout their academic experiences
- Help students to learn and better retain knowledge by being involved in the teaching process

All of which are very desirable in UK universities at this time, indeed one of the requirements of the Quality Assurance Agency is that all programmes have a Programme Specification, which in all cases will include the Expected Learning Outcomes.

Supporting this approach to curriculum design, Huack (1998b) states that successful curriculum reform has been listed as the primary reason university programmes in construction management implement active outcomes assessment programmes. Huber (1994) collected data designed to measure the perceptions of module leaders toward outcomes assessment, and concluded that they enable the promotion of:-

- ♦ Curriculum changes
- ♦ Improving teaching and learning
- ♦ Programme enhancement or curriculum evaluation techniques

This approach is therefore deemed as most applicable to the re-evaluation and reform of construction management programmes.

2.5.7.2 Adopting an interdisciplinary approach

The Latham (1994) and Egan (1998) Reports both stress the need for construction professionals to work more closely at an earlier stage in construction project development in order to reduce the adversarial nature of the construction industry. In order for this to occur, students have to be exposed to other professions throughout their course of study, in order to identify their own role and that of others in a complex industry. The Toyne Report(1993) recommended that a general awareness of the importance of environmental issues(global and local) and the need for responsible environmental stewardship is important, plus an awareness of the ways in which the activities of the individual's organisation are liable to impact upon the environment.

Added to this the Report also recommends that graduates should possess the capacity to detect and anticipate specific situations, arising from the organisation activities and have an appreciation of the full range of costs and benefits likely to result from responding(or not responding) to the situations identified. As the construction industry is complex and fragmented with many of the decision makers working for different organisations and being of different professions, the ability to design solutions which reflect a holistic appreciation of the environmental context requires working closely with other professions.

Jucker (2002) supports this idea and believes that we need to overcome the disciplinary straightjacket of current education, which is one of the main reasons for our unsustainable situation because it prevents us from looking beyond one's own narrow field of vision. Wolfe(2001) also sees the benefit of an interdisciplinary approach to the environment, as greatly improving the programme in many ways, as it will introduce students to the different ways of approaching environmental issues. This is further supported by Norberg-Hodge (2000) who believes that we need to actively promote the generalist-the one who sees connections and makes links across different disciplines.

Graham (2000), whose research focussed on increasing environmental literacy through interdisciplinary approaches found that it is important for teachers to explain the role of building professions in relation to each other in the development of resource aware practices and the procurement of sustainable buildings. One of the goals of the RMIT Faculty of the Constructed Environment (where his research was based) was to enable students to situate and explain their own environmental perspective using examples appropriate to their professional specialisation. Of course this approach relies on teachers themselves having enough knowledge of other professions in order to explain roles to students, and requires the teachers themselves to be free of excessive bias to their own profession, which is not always the case in built environment faculties.

There is a consensus of opinion that using interdisciplinary approaches to teaching as much as is possible, without students losing the opportunity to develop the skills and acquire the knowledge required for their chosen discipline, is a very positive advantage in construction courses.

However Fettig et al (2002) identified some possible pitfalls and they believe that curriculum design should include interdisciplinary education, but with an emphasis on practical elements. This is because there has been too much emphasis on technical environmental problems that concentrate little on practical or real life problems. A central goal should be that undergraduates are enabled to work on a technical problem in its entirety, looking at all aspects and with people from other disciplines that would be involved in the 'real world'.

In conclusion Robson et al (1996) summarise the benefit of this approach as:
'by bringing together disciplines and focussing their efforts on a common project, the students prepare to better meet the needs of industry'

2.5.7.3 Integration v Fragmentation

In most HE institutions a review of the curriculum is carried out on an annual basis, which is to be applauded. However an unfortunate consequence of annual curriculum reform is that new developments are incorporated on an ad-hoc basis. They may be included in the teaching of a module where they are not best placed and do not add to the academic rigour of a module. They may be introduced at the wrong level because there is space in the programme at that level to do so, and they may be included in modules where the module leader has no expertise and has no time to develop sufficient understanding of the topic before the module is due to be delivered. This has been the case at Liverpool JMU with regard to sustainability and has led to a fragmentation of the teaching of environmental issues. Jucker (2002) confirms the limitations of a fragmented approach by stating that we cannot patch on a few environmental courses or a bit of green content here and there if we are to ensure that environmental literacy of students is to be achieved.

Graham (2000) also believes that aspects of environmental performance are not objective empirical concepts but are subjective and context dependent. Therefore they need to be placed in a framework for understanding that explains how all of these activities interrelate and why they are important, and that acknowledges the student's previous experience of, and attitudes to, all of these activities.

Mills et al (1996) further state that all information presented in service courses must relate directly to skills being developed in the building construction core major courses, which interpreted means that all modules contributing to the programme must have outcomes that relate directly to the aims and objectives of the overall programme.

These findings concur with the idea that integration is the way forward if environmental literacy is to be achieved. However there is enough evidence to suggest that a good model would be to have integration in as many subjects as possible, but a small amount of fragmentation would help to consolidate student knowledge.

2.5.7.4 Identification of what needs to be included in the curriculum and how these elements should be included

Huack(1998a) proposes the following as essential elements of a construction curriculum:

- Integration of resources
- People management
- Built environment
- Managing processes
- Graphic communication
- Regulatory agencies
- Safety
- Team/Group dynamic
- Problem solving
- Ergonomics
- Career options
- Adaptability/Flexibility
- Applied technical skills
- Cultural diversity
- Materials processing

- Scheduling
- Legal issues
- Understanding maths and science
- Global considerations
- Environmental solutions
- Project management
- Strategic/Business planning

The list given, shows global considerations and environmental solutions in a way that could be interpreted as two individual module topics. This would result in a fragmented curriculum. However this needs to be read in context and construction management courses are NOT environmental courses and the graduates will be expected to have a knowledge of all aspects of the industry, plus certain technical and transferable skills. If all they know about is the environmental impact of construction they will be of little use to the industry.

The aim of a construction management programme is to educate students in all aspects of the industry so that they will be gainfully employed for their working life, but also enable them to become environmentally literate so that in the long term they may be able to change the attitude of the industry to become more environmentally focussed.

Williamson and Bilbo(1999) identified that the indications are that graduates are gaining acceptance in the industry as professional managers rather than skilled technologists. More emphasis should be placed on administering the construction technologies and the design/construct/manage interface, than performing them. This therefore stresses the need for students to understand the global considerations with regard to construction techniques, understanding environmental solutions and having the skills and knowledge to be able to manage these solutions. Huack's list can interpreted by either a fragmented or integrated approach but is still a good guide for the broad subject areas that need to be included in the curriculum.

An aspect that is missing from Huack's list is research. Research capability can be embedded into undergraduate programmes to benefit both industry and academia. However, as Goulding and Turner (2003) found that even though this requires considerable resource allocation and commitment from all parties to ensure that the appropriate support mechanisms are in place to deliver expectations, it is an essential element of the curriculum. The importance of research in the curriculum is endorsed by McLernon and Hughes (2003) who believe that the link between teaching and research in the curriculum will lead to 'scholarship' and students will benefit from an improved education that will lead on from this. Ratcliffe (2003) suggests that the impact of research in the curriculum and assessment of research projects allows the student to view their learning through a different paradigm. They move from being asked the question "How well do you know it?" to "What difference will doing this make?"

Therefore there is support for the inclusion of research in the curriculum. However at LJMU there has been much concern over the standard of research skills evidenced in the dissertation modules. One of the reasons cited by members of staff is that the students do not understand research methodologies sufficiently before the modules start. A resolution to this problem is to introduce research methodology earlier in the curriculum.

Graham (2000) states that resource efficiency (sustainability) is a quality of the building, but resource awareness is a quality of the building professional and as such the latter is an aspect of environmental literacy. Therefore it is resource awareness that is the most important thing to achieve. However it is important that teachers understand and explain the role of resource efficiency in relation to other building environmental performance attributes of sustainable design and construction. And further that these things need to be taught in a manner that encourages students to develop the kind of personal and professional attitude that will empower them to apply their skills in practice. Therefore content along with methods of teaching and assessment are the most important aspects in a curriculum designed to increase environmental literacy.

The content of the curriculum is in many cases dictated by the professional body that accredits the course, certainly in the case of construction management courses that are validated under the CIOB framework. Although the content may be fine, the objective of students becoming environmentally literate may not be achieved because the methods of teaching, learning and assessment have not been developed sufficiently.

Graham (2000) uses the theory for learning literacy in Australia developed by Cambourne (1988) as his basis for the model of learning that applies to environmental literacy:

1.Immersion: students must be consistently surrounded in environmental purpose, application and outcomes of using it. Environmental literacy must be integrated into the core curriculum.

2. Demonstration: What does it mean to be environmentally literate and how can a student be environmentally literate? Integrating environmental literacy into the curriculum may require the same effort that is being applied to integrate 'flexible delivery' or 'IT' into curricula. Academics need to be resourced and mentored so that they themselves can become environmentally literate.

3. Engagement: students need to be convinced that they can actually make a positive difference to the state of the world and that there is hope for a sustainable future.

4. Expectation: What is set out is learnable by them. Students expect knowledge to be communicated by 'significant others', they need to believe that they can use what is learnt, it is not just hypothetical,

5. Responsibility: teachers have a responsibility to provide situations of immersion, demonstration and foster engagement. Learners are responsible for becoming proficient in what is being taught and for deciding which information is the most important information. In order to be motivated to do this they must be convinced that being environmentally literate will be of benefit to them.

6. Approximation: Students need to try out and test their skills and attitudes, gain feedback and try to improve on a continuing basis through assessed coursework.

7. Response: this is basically teachers giving students giving feedback on their work which is informative

8. Use: Application of knowledge either individually or in a group, opportunities should be given to solve 'real life' problems.

All of these points are basic good practice for teaching staff, but only the use of quality monitoring tools can ensure that this best practice is adhered to by all teaching staff.

A possible addition to the list could be **relevance** and this could be achieved by the inclusion of site visits for as Stier (1996) advocates, the use of field experience is an essential component in the formal education of technology students, and a great deal of the construction management curriculum is technology based.

It is a Quality Assurance Agency(QAA) requirement that Personal Development Planning (PDP) opportunities have to be embedded into all undergraduate programmes in the UK. The purpose of this is to encourage students to reflect on their personal development and plan how they can make improvements to their knowledge and skills. PDP is a useful tool for allowing students to muse on the relevancy of the knowledge they have acquired to a wider perspective and potentially change attitudes. This could be potentially very important when issues like sustainability are considered as it has been identified that increased knowledge can change attitudes, but only if there is a mechanism to facilitate the change in attitudes. PDP could be that mechanism. Reflective practice is seen as the way forward for both students and academics alike and there is much research that shows that reflective learning leads to better learning (Davis, 2003). However Kuit et al. (2001) found that whilst the only thing that was required for reflective practice was time, this is a rare and precious commodity. Mechanisms that allow for PDP to be developed effectively and efficiently within the time restrictions of a modular programme need to be developed.

In conclusion it can be seen that it is extremely important for a curriculum to contain the correct subject content, and also to identify clearly how the content is to be delivered and assessed in order for the student to achieve environmental literacy.

2.5.7.5 The Importance of Experienced Based Learning (EBL)

Work or Experience Based Learning has long been regarded as an essential part of any vocational degree programme. This can be achieved through work placements, thick or thin sandwich placements or full time work combined with part time study. The majority of construction management programmes in the UK offer all these modes of study and construction companies generally decide on a strategy to adopt with regard to employees. Some prefer their employees to work and study at the same time, whilst some offer sandwich placements and others work placements supported by sponsorship for the study programme. Whatever mode is chosen this experience is viewed as essential, indeed Auchey et al (2000) believe that a primary goal of construction education programmes is to be a source for dynamic, practical and innovative building construction knowledge. And the cornerstone of building a strong construction education curriculum is the balance between practical experience based knowledge and academic enquiry.

Hopkins(1937) quoted by Mills et al.(1996) stated that knowledge becomes experience and experience becomes knowledge, thus illustrating that experienced based learning has to be coupled with academic knowledge to ensure that the learner continues to learn both before and after graduation and that this is not a new concept.

Jucker (2002) believes that this is of the utmost importance with regard to environmental education and states that integration of education into real life is a necessary basis for any effective learning. Education for Sustainability should therefore aim to be experiential learning, starting from real problems, grappling with multi-dimensional, trans-disciplinary nature in an attempt to come to real, rather than reductionist solutions. We have to accept the complexities of real life and integrate teaching, research, personal behaviour and professional activity within the framework of sustainability.

Jucker's findings clearly identify that for students to become environmentally literate they need to firstly gain knowledge of the environmental impact of the industry and apply this knowledge to theoretical problems in the educational setting. They then need to be exposed to real life problems, and although these can be simulated in the academic surroundings, it is far better to be exposed to experience in the workplace and some stage in the student's programme of study. This idea is supported by Moon's (1999) schema to guide reflective activity.

2.5.7.6 Barriers that can affect curriculum development

The barriers that can prevent a curriculum being developed that totally satisfy the learning outcomes that it sets out to achieve can be placed in two categories.

a. Basic logistical problems
b. The adverse effects of the 'hidden curriculum'

Basic logistical problems include the following:

- All universities have frameworks for the structure of programmes, usually credit based. This can seriously restrict the amount of material that can be delivered, the type and amount of assessment that can be set for a module of a given credit rating and the teaching approach that can be taken. Therefore the tutor may understand the best way to enable students to become environmentally literate through studying a series of modules, but do not have the time to achieve this within the constraints of a credit based curriculum.
- The adoption of semesters can again hinder developments in this area as the students may study a module that has a strong environmental context in year 1 semester 1, and this may not be proceeded with another similar module until year 2 semester 2, thus a year gap in study will occur. Integration of environmental issues in all subjects should address this problem but this requires a commitment to this approach by all teaching staff. The adoption of year long modules especially for project based subjects should also reduce this problem, but timetabling of staff and study rooms can still lead to the problem not being resolved
- University programmes have to be validated internally, and the guidelines for this validation come from the Quality Assurance Agency. Programmes that are professionally accredited have also to satisfy the requirements of the relevant professional body, and these requirements may be very

different to the University. Therefore in the ideal world the curriculum would be designed by the academics with input from industry to achieve specific learning objectives but may fail to satisfy the university and/or the professional body. This will ultimately lead to the curriculum being changed.

- To incorporate changes to any great extent requires staff to be able to deliver the curriculum. This may need a great deal of staff development and commitment, for which the funding may not be available.

Possible adverse effects of the hidden curriculum have been identified by Jucker (2002). Any potential educational impact is held in check by what is called the hidden curriculum. These are formidable forces and educators should not harbour any illusions about the possibilities of learning to counteract them. The most important ones are:

- The economic structure which is currently based on the exploitation of people and nature, and aiming for growth within a closed system
- Institutional structures, tax systems and ideological beliefs encouraging and entrenching unsustainable behaviour
- All forms of media and propaganda, which deny access to real knowledge about the real world
- Within the educational sector, an important part of the hidden curriculum is constituted by the architecture, setting, atmosphere and day to day running of the educational institutions (Orr, 1994).

It is extremely difficult for teaching staff to change deep rooted beliefs and understanding on any subject and the environment is one of those subjects. The backgrounds of students can affect not so much their learning, but most definitely their attitudes, and it is only changes in attitude that can lead to improvements in environmental behaviour.

2.5.7.7 Models for curriculum development that will lead to environmentally literate graduates

In order to develop a curriculum the starting point is to identify the qualities that environmentally literate construction professionals need to have. From this list of qualities the knowledge that they require to achieve these qualities can then be determined. This can then be further analysed to define what is identified by Emmit and Graham (1991) as stages of learner empowerment that can be related to the levels of study of an undergraduate programme.

Emmit and Graham consider that learner empowerment involves learners, teachers and the course as shown in figure 2.11. Students should be encouraged to use these statements to identify the difference between their personal approach to their profession and that of others, and to map their progress toward contributing sustainable buildings to society. The diagram further illustrates the importance of reflection in the learning process.

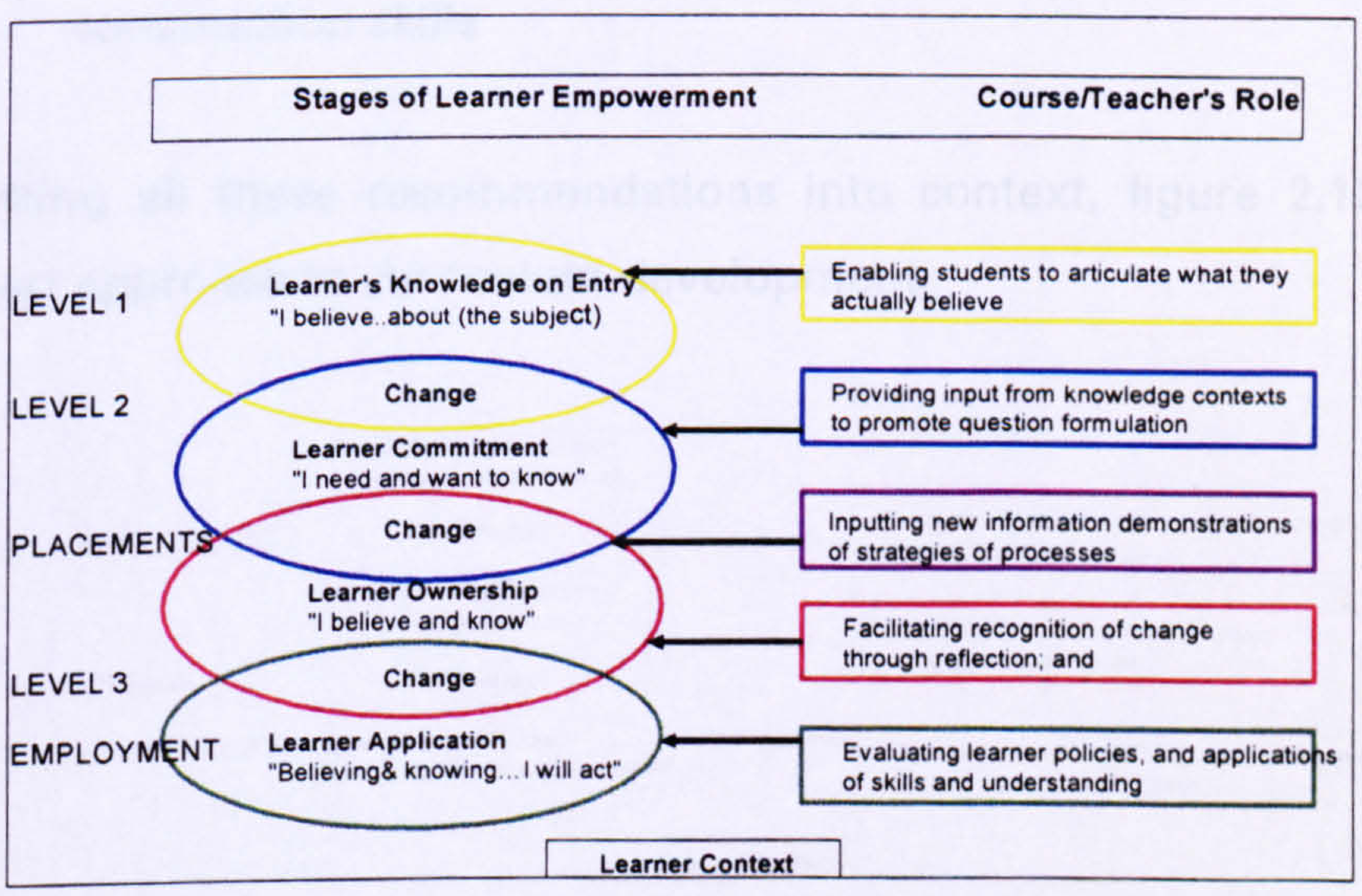


Figure 2.11 Model of teaching for learner empowerment (Graham, 2000)

Utilising the concepts detailed in figure 2.9, and a list of essential elements of a construction curriculum, such as Huacks (1998b), a list of definitive learning outcomes for each level of study and the overall programme can be compiled. Huack's recommendation for successful curriculum design can then be followed:

- Start the curriculum reform from a comprehensive list of desired learning outcomes not from a list of course titles
- Create this list of learning outcomes from external sources; not just from the original course data
- Consider the curriculum as a whole; not by piecemeal changes to one course at one time
- Establish an outcomes assessment process which measures the success at attaining the stated learning outcomes, i.e. you must be able to test that the outcomes are achieved

On completion of an initial draft of the curriculum, it must be tested to see that it complies with the recommendations of Mills et al (1996) who identified some of the main objectives of a construction programme as:

- It must balance the construction education concepts of practical experience based knowledge with academic enquiry
- It must be a dynamic, practical, applied academic model
- It must maintain a strong identity within the university and industry
- It must integrate people and communication skills with pragmatic building construction skills

Putting all these recommendations into context, figure 2.12 illustrates a flow chart approach to curriculum development.

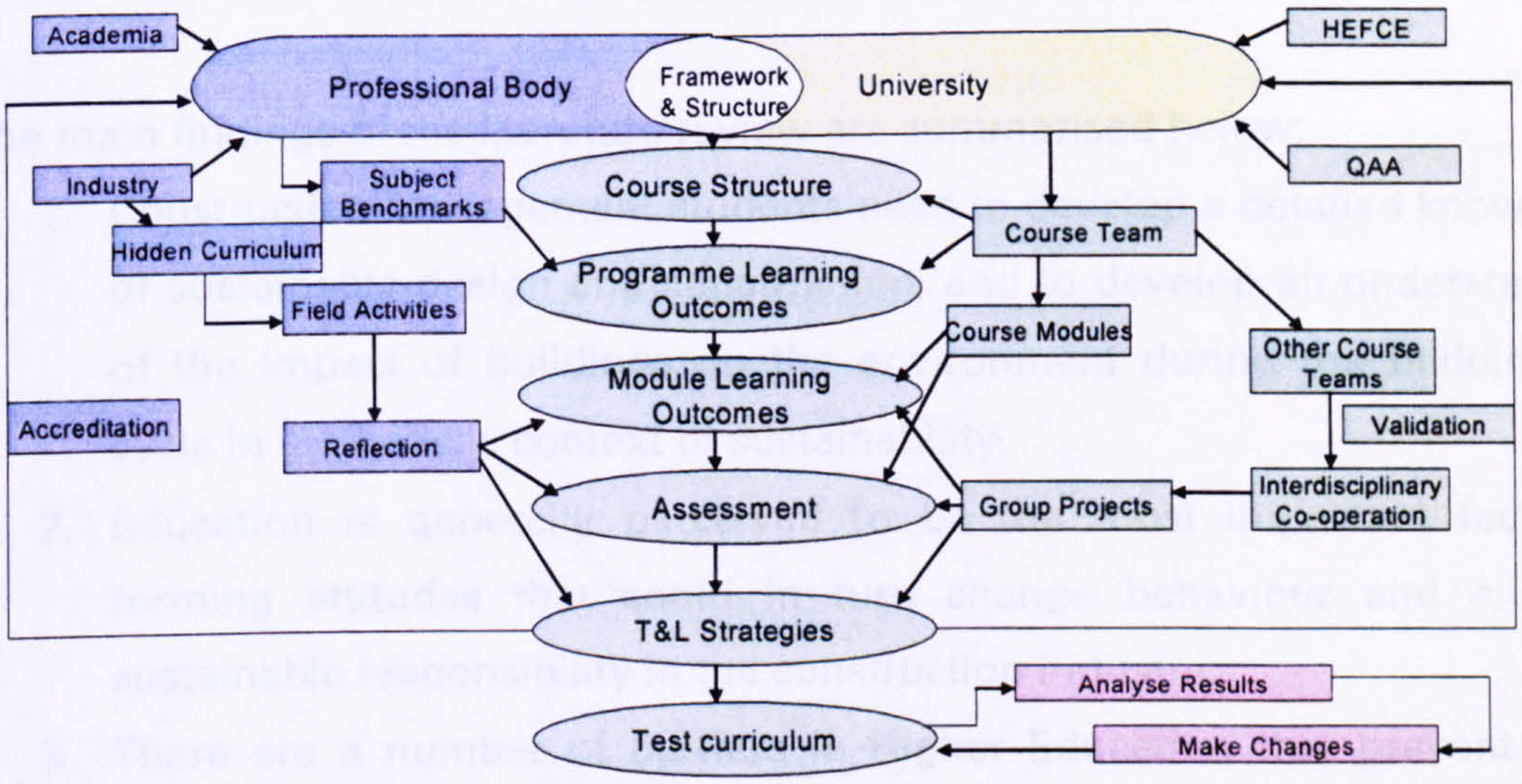


Figure 2.12 Integrated Curriculum Development Model

2.6 Conclusions of the literature review

The main findings of the literature review are summarised below:

1. Construction Management students need to develop a detailed knowledge of sustainable design and construction, and to develop an understanding of the impact of buildings on the environment during the building life cycle in the holistic context of sustainability.
2. Education is generally perceived to be the most important factor in forming attitudes that could in turn change behaviour and enhance sustainable responsibility in the construction industry.
3. There are a number of barriers in Higher Education that prevent more inclusion of environmental issues in the curriculum, but these are not insurmountable.
4. The government is proactively encouraging curriculum greening via a number of reports and proposed strategies, but progress regarding implementation appears to be slow.
5. The CIOB educational framework appears to be very prescriptive as to how environmental issues should be incorporated into the curricula of programmes that the Institute accredits.
6. The three main recommendations for curriculum design include mainly integration as opposed to fragmentation, use of multidisciplinary projects and the utilisation of a learning outcomes approach.
7. The starting point for curriculum development is to identify the qualities that environmentally literate professionals need to have, and for teaching staff to build into the curriculum opportunities for students to critically analyse and reflect on preconceived beliefs regarding the environment.

The findings illustrate that the construction industry needs to improve its environmental performance and additionally they indicate that not enough is being done by the HE sector to educate construction students to a level where they may be able to have some impact on the environmental behaviour of the construction industry. This is deemed by earlier writers to be because there is a lack of understanding about what the concepts of sustainability are in the context of construction work and buildings and that there are many barriers that prevent more inclusion of environmental subjects in the construction curriculum.

However an improvement in student knowledge is essential and the next stage of the research project aimed at identifying whether the findings of earlier writers were correct. In addition, the collection and subsequent analysis, of data aimed to develop possible solutions that could assist in overcoming potential barriers for more environmental focus in the curriculum that could improve knowledge and enhance literacy in sustainability.

3.0 Methodology

3.1 Justification for the need to collect primary data

The literature review aimed to clarify and expand the author's knowledge of what sustainability means in the context of construction work and buildings, what the construction industry and UK government are doing to address the environmental impact of construction work and buildings, how professional bodies are attempting to improve environmental literacy of graduates via their educational policies and what is deemed to be good practice in environmentally focussed education.

A further objective was to identify gaps in knowledge that the literature review could not answer and develop a methodology for data collection and analysis that will allow the main aim of the project to be achieved. The overall aim of this research is to produce a set of well-developed concepts that can be used to explain or predict phenomena related to curriculum modelling. The literature review does not give the data required to produce this, and therefore primary data needs to be collected and analysed systematically to support any recommendations made.

The literature review strategy was determined by the need to answer the following questions related to curriculum design:

- What do construction management students need to know about sustainability?
- What approaches has the construction industry taken to reduce the environmental damage of construction work and buildings and do students need to know about these?
- Are the professional bodies promoting sustainability literacy sufficiently, or do universities need to go a step further?
- What are the best strategies of achieving sustainability literacy via the construction management curriculum, and is it feasible to implement these strategies in UK universities?

These questions have only been answered partially, but sufficiently enough to allow for a methodology to be developed, that when complete and data analysed, should allow for the overall aim to be achieved and its validity tested.

3.2 Potential Research Methodologies

Bagnall and McClelland (1998) defined research as the function that allows us to obtain information and data about activities, events and occurrences in order that we can identify, define, monitor and better understand issues, problems and processes through evaluation. Research should highlight the information required to address the issues, problems or processes, then identify the data gathering design and methodology best suited to the information, provide interpretation of the results and present arguments, discussion and critical evaluation of the findings.

The research undertaken cannot be classed as educational research or construction management research. It falls between the two and is concerned with the education of construction managers. However the author believes that the methodologies that will achieve the most success are those that are more clearly linked to construction management research, but they need to be verified as valid methodologies in educational research also. Research methodologies are generally divided into two main categories: Quantitative or Qualitative. Within these two main categories there are a number of methods that can be used to capture data and subsequently analyse it.

Quantitative research is defined by Creswell (1994) as an inquiry into social or human problems, based on testing a hypothesis or a theory composed of variables, measured with numbers and analysed with statistical procedures in order to determine whether the hypothesis or the theory hold true.

Quantitative analysis may be more appropriate to assess the behavioural or descriptive complements of the Built Environment because a quantitative research design has always been concerned with defining an epistemological methodology for determining the truth-value of propositions and allows flexibility in the treatment of data, in terms of comparative analysis, statistical analyses, and repeatability of data collection in order to verify reliability. (Amaratunga, 2002)

The strengths of quantitative methodologies for Built Environment research are:

- comparison and replication are allowable;
- there is independence of the observer from the subject being observed;
- the subject under analysis is measured through objective methods rather than being inferred subjectively through sensation, reflection or intuition;
- reliability and validity may be determined more objectively than qualitative techniques
- the method is strong in measuring descriptive aspects of Built Environment
- the approach emphasises the need to formulate a hypothesis for subsequent verification
- it helps to search for causal explanations and fundamental laws, and generally reduces the whole to the simplest possible elements in order to facilitate analysis (Easterby-Smith, 1991)

Qualitative data is a source of well-grounded, rich descriptions and explanations of processes in identifiable local contexts. With qualitative data one can preserve chronological flow, see precisely which events led to which consequences, and derive fruitful explanations. Qualitative research may be conducted in dozens of ways, many with long traditions behind them.

Qualitative methods, especially observation, or unstructured interviews, also allows the researcher to develop an overall "picture" of the investigation. (Amaratunga, 2002)

Qualitative data analysis is defined by Dey (1993) as a series of related processes that involve describing phenomena, classifying it and examining how concepts interrelate. It involves describing, classifying and categorising data by coding, leading to connections and comparisons of the data to produce an end account. Kelle (1997) stated that when coding and categorising data, researchers bring their own ideas and theories to the research that shape how and what is coded.

Analysis of data involves looking for patterns, regularities, variations, exceptions, differences, commonalties and connections between concepts.

Both of these methodologies have advantages and disadvantages. The main disadvantages of quantitative data collection are that in order for the data collection to be reliable, the design of the collection tool needs to be nearly perfect because you will only get one chance at collection of the data. This problem can be reduced by piloting of the tool but even extensive piloting cannot illustrate all of the failings of the tool. In addition to this, the sample chosen for questioning needs to be large enough to ensure that enough returns are received to allow for statistical analysis of the data. The problems of non return of questionnaires are well known to all quantitative researchers and the problem seems to be worsening with society going into questionnaire overload. The final concern with quantitative data collection is that it can be quite shallow and the respondents only answer the very specific question asked of them, and are not allowed to input their own opinions.

Qualitative data is usually collected via a form of discussion either structured, semi structured or unstructured. This allows for the conversation to deviate and for the interviewee to broker their opinions. However, one potential problem is that the interviewer can become distracted away from the main purpose of the interview and a large part of the transcription of the interview may be irrelevant. The other disadvantage of a qualitative methodology is the reliability of the analysis because the analyst may be biased because of their own perceptions and feelings on the subject. This can affect their interpretation of the data, but can be overcome by undertaking a validity test or by using computer systems that remove bias.

There are therefore advantages and disadvantages to both approaches and a basic comparison of the two methods is given in figure 3.1

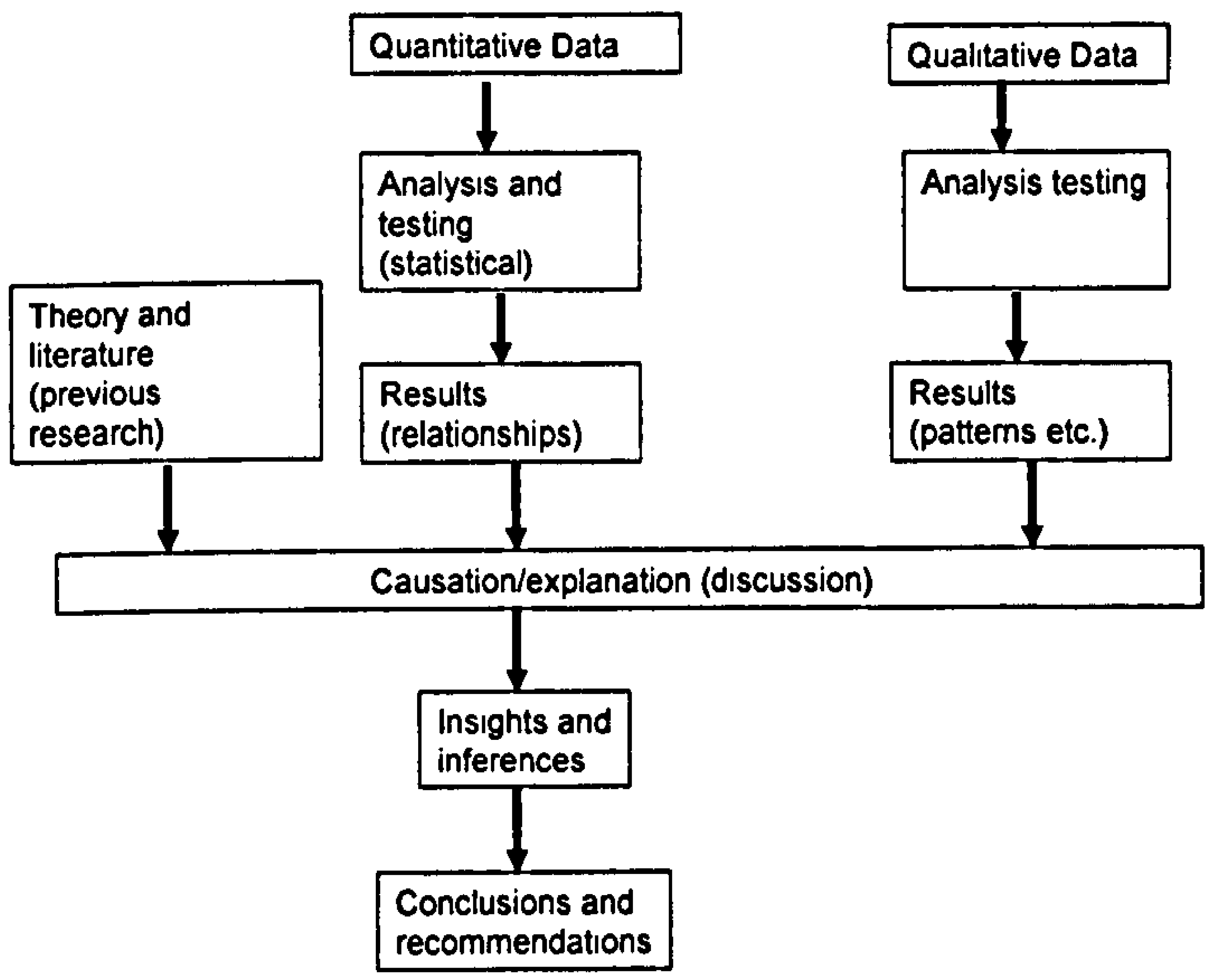


Figure 3.1 Comparison of potential of research methodologies

A decision needed to be made as to which methodology would achieve the required results upon completion of the research project. However the author could see the benefits of using both methodologies at each stage of the data collection, with one methodology taking greater precedence over the other in each of the phases. Therefore the decision was made to adopt a mixed model methodology for collection of data, and triangulation for the analysis of the data.

The pragmatic approach of mixed methodology for built environment research is advocated by Raftery et al (1997) who state that qualitative approaches or quantitative approaches are both valid methodologies and that neither is superior to the other. Researchers in the construction field should conduct research by defining the problem and then applying the most appropriate method chosen from an unconstrained and wide range of possible approaches.

Wing et al (1998) stated that research should not be based on description; it requires analysis, a form of systematic enquiry. It looks for relationships, comparisons, predictions and generalisation. Empirical investigation does not have to be only quantitative; it can also be qualitative. This research is not involved in contracting issues or the management of construction projects, but it still falls into the remit of construction management research.

These views are supported by Morse (1991), Csete and Albrecht (1994), Tashakkori and Teddlie (1998) and Amaratunga (2002) who states that:

'There is no uniquely best approach to research, either in the natural world or in the Built Environment in particular, and the best that can be done is to describe the ways in which research is carried out in a variety of situations. I do not want to suggest that a mixed methodology is the only suitable research design, rather that it is an appropriate and, at times, desirable design. The overall choice needs, of course, to be the most suitable to achieve the objectives of the specific piece of research. A mixed methodology, however, has a number of advantages within Built Environment research, as well as other disciplines, and may be able to enhance the quality of such work.'

This approach is also supported in the context of educational research by Niglas (1999, 2000, 2001) who undertook a survey of 87 educational research papers to identify methodologies that were being adopted in the 1990s. Her findings were that even if authors believed that they were undertaking research using a mono-method approach, there were lots of examples where in fact mixed methodologies were being used and that these approaches had enhanced the quality of the end product. Her conclusion of the study was that on the level of educational research practice the move has been made towards peaceful coexistence between methodologies, suggesting that in the future qualitative and quantitative approaches to educational inquiry will not be taken as mutually exclusive and competing paradigms, but rather as approaches which are useful in different ways and therefore have the potential to complement each other.

As a final justification for this dual approach, Murray Thomas (2003) firmly believes that the best answers frequently result from using a combination of qualitative and quantitative techniques, and this approach has also been validated for use in construction research by Raftery et al.(1997).

However a word of caution that needs to be considered when undertaking a mixed methodology approach is given by Hammersley (1995) who argues that to look at quantitative and qualitative methodologies as simply different techniques which should be combined in order to cancel out their respective weaknesses is to neglect the 'different methodological arguments associated with qualitative and quantitative methods' as well as to confine the possibilities of either methods.

Every attempt has been made to ensure that this has not occurred.

It is deemed appropriate to adopt the mixed methodology approach as its validity has been accepted by both built environment and educational researchers. The methodology accepts the pre-eminence of the research questions as the basis for consideration for designing the research strategy. Adopting this approach allows the author to explore issues related to the legitimacy of alternative research paradigms. However for the purpose of the research design the principles of construction management research will be referred to.

Construction management research is generally agreed to require breaking down the work into what is seen as construction management related and determining what levels of quantitative and qualitative research is needed (Hughes,1997; Runeson,1997; Seymour et al.,1997; Seymour et al.,1998 and Wing et al, 1998).

Hughes (1997) stated that construction management is not a different set of management, but a sub-set of management and that problems faced in the construction industry are examples of problems already faced elsewhere. He defined good research as that which contributes to our understanding and describes models of scientific enquiry as useful in defining research projects and in acquiring data. To support using this approach within this project, green curriculum design approaches are not different from curriculum design generally and principles developed are transferable to all aspects of the curriculum.

3.3 The mixed methodology approach

The different approaches to mixed methodology for data collection and analysis as opposed to the mono-method approach are outlined overleaf:

Mono-method studies follow in all stages of the inquiry 'one of the predominant paradigms' (Tashakkori & Teddlie (1998). Thus, they are either purely quantitative or purely qualitative studies.
Mixed method studies combine the quantitative and qualitative approaches in a single study or multi-phased study. Here quantitative and qualitative approaches are regarded relatively independent, as the authors stress that all mixed method designs use triangulation techniques.

Mixed model studies 'combine the qualitative and quantitative approaches within different phases of the research process'. Here qualitative and quantitative methodologies can be interwoven in different ways. They can be present as the single application on different stages of the study or they may be used simultaneously in integrated manner on the same phase(s) of the inquiry. Niglas (2000).

Examples of the use of the mixed method approach are given in Borthwick (2002) and Ross (2005).

Borthwick (2002) undertook an initial approach to data collection using interviews (qualitative) and using the subsequent analysis of the data to develop a questionnaire (quantitative) to complete the research.

Ross (2005) used the same approach but went further in using interviews (qualitative) to validate the findings of the results of the questionnaire.

In both examples the data in each stage was analysed using an appropriate analysis tool, but there was no triangulation of the different data sets undertaken in the separate phases.

The mixed model approach has been used in this research project and both qualitative and quantitative methods of collection and analysis of data have been used in each phase. The main form of data collection has been classified as either quantitative (phases1 and 3) or qualitative (phase 2). At each stage of the work the following questions were asked before determining the method to be used:

- What needs to be known?
- What is the best way to achieve this knowledge?

Figure 3.2 outlines a flow chart of decision making that was used at each stage of methodological design showing the considerations that were undertaken for each phase to ensure that the most valid and reliable findings could be made.

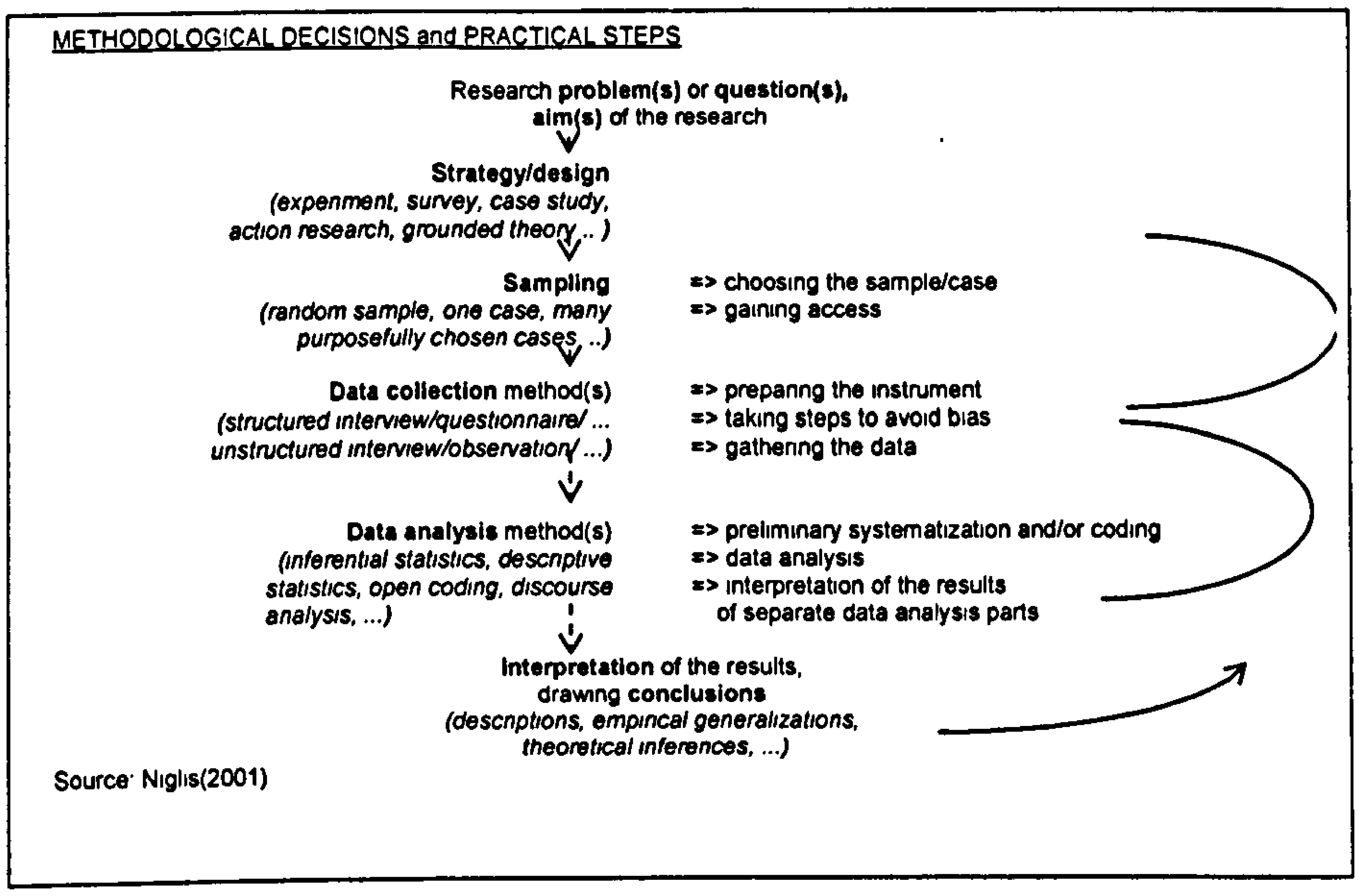


Figure 3.2 Methodological decisions to be made and steps taken in the process of the research study (Niglas, 2001).

3.3.1 Triangulation

Triangulation is the combination of methodologies in the study of the same phenomenon. The assumption in triangulation is that the effectiveness of triangulation rests on the premise that the weaknesses in each single method will be compensated by the counter-balancing strengths of another (Amaratunga, 2002).

Denzin (1978) clearly identified four different types of triangulation:

1. **Data triangulation** – the use of a variety of data sources and data sets in a study. Data may be both qualitative and quantitative, gathered by different methods or by the same method from different sources or at different times.
2. **Investigator triangulation** – the use of several different researchers. Here the importance of partnership and teamwork is underlined as the way of bringing in different perspectives.
3. **Theory triangulation** – the use of different theoretical viewpoints for determining competing hypotheses as well as for interpreting the single set of data.
4. **Methodological triangulation** – the use of multiple methods to study a single problem or phenomenon. It may also include the use of the same method on different occasions and situations.

The concept of triangulation is based on the assumption that by using several data sources, methods and investigators one can neutralize bias inherent in one particular data source, investigator or method. In this study data triangulation and methodological triangulation approaches have been used.

3.4 Summary of methodological approaches used for each phase

The choice of method of data collection used for each phase will be overviewed in 3.4.1, 3.4.2, 3.4.3 and 3.4.4, and further expanded and clarified in chapters 4.0, 5.0, 6.0 and 7.0 but a basic summary is given below.

Phase 1- Chapter 4	Interviews with programme leaders Qualitative and **Quantitative** elements	Interpretivism and identification of variables to triangulate. **Qualitative**
	Student knowledge and attitude appraisal Questionnaires- **Quantitative**	Means, modes, standard deviations, Chi square and Z tests. **Quantitative**
	Industry attitudes and knowledge Questionnaires- **Quantitative**	Descriptive statistics-**Quantitative**
Phase 2- Chapter 5	Semi structured interviews with smaller sample of programme leaders-**Qualitative**	Data coded and analysed using NVivo software- **Qualitative**
	Some elements of the interviews generated quantitative data- **Quantitative**	Means and modes used to analyse these elements and triangulated- **Quantitative and Qualitative**
Industry Data Chapter 6	Data collected from industry using a questionnaire. This method was intended for use as the testing of the model tool, but was deemed to not be suitable. The findings have been used to validate previous findings. **Quantitative**	Very basic analysis undertaken due to the poor nature of the data received **Quantitative**
Phase 3- Chapter 7	Student knowledge and attitude testing during simulation of the model via questionnaires.- **Quantitative**	Data imported into SPSS software and analysed to produce and multi variate general linear model-**Quantitative**
	Student knowledge and attitude testing via group interviews to verify findings- **Quantitative**	Summarised and interpreted, triangulated with qualitative data-**Quantitative**

Table 3.1 Summary of data collection and analysis methods

All the summaries given in red, identify where triangulation took place and validates the claim that the data collection and analysis for this research project has been undertaken using a 'Mixed Model' method.

3.4.1 Phase 1

Phase 1 was primarily a pilot study to clarify and expand on information obtained via the literature review and to assess whether there was the potential to undertake a PhD study in this subject. Data was collected from three sources:

1. Construction Management Programme Leaders using structured telephone interviews
2. Construction Management final year students using a paper based questionnaire issued by programme leaders.
3. Industry by the use of a paper based questionnaire sent by post

The interviews with the programme leaders aimed to identify the current situation regarding the inclusion of sustainability in the construction curricula, barriers that prevent more inclusion and potential proposed interventions that they may employ in the future. The interviews were also used to determine variables to allow statistical analysis of the student data and which of the programme leaders were the most suitable to be approached to be involved in phase 2.

The student questionnaires aimed to identify student knowledge of environmental issues related to construction and buildings and determine attitudes towards the environment.

The industry questionnaires aimed to identify attitudes of construction professionals to the environment, knowledge of how sustainability can be achieved in construction and buildings and what the industry believes is the best way to change current practices.

The programme leader interviews were analysed separately and trends in responses identified. Some of the responses were used to generate variables to allow the students to be grouped so that statistical analysis methods could be employed to analyse the data. Other variables were identified from the questionnaire responses. As statistical analysis was possible because there were sufficient questionnaires and variables identified, non-parametric testing was used to analyse the data because the data did not follow a normal distribution. Templates were set up in Excel spreadsheets, data imported to SPSS and tests undertaken.

There was a good response rate from the industry survey but there was insufficient data available to determine variables and undertake statistical testing of the data. Therefore only descriptive statistics were used to illustrate the feedback from the survey. However the results were sufficiently informative as to industry stance in the public sector at the time of the data collection.

As both qualitative and quantitative techniques were used to collect and analyse date, this supports the mixed model methodology approach. Details of the population samples, question development, method of analysis and results of the analysis are given in detail in chapter 4.

3.4.2 Phase 2

After the analysis of the phase 1 data there were areas of knowledge that needed further clarification and expansion. It was identified that these gaps were predominantly in the information given by the programme leaders. In some instances they had been asked a question and responded yes or no, and phase 2 attempted to find out why they had answered yes or no. The data required was richer and deeper than was possible to obtain during the telephone interviews and therefore a qualitative methodology was required to gain this richer data.

It would have been difficult to undertake face to face interviews with all the programme leaders interviewed in phase 1 and therefore the decision was made to reduce the sample. To do this, a cluster analysis technique based on a sampling grid was used. Key questions from phase 1 were identified and the programmes placed in the quadrant of the grid that correlated to the responses to these questions. This reduced the original twenty two programmes down to eight.

Eight face to face interviews were undertaken, taped and then transcribed. Although this approach was predominantly qualitative, there were some questions that required the interviewee to state their agreement level. This data is quantitative and was used as the validity check for the interpretation of the qualitative data.

There were two unsuccessful attempts to analysis the qualitative elements of the data. Initially the interpretative research paradigm methodology was adopted and proved unsuccessful. This was followed by an attempt to manually open and then axially code the data. As both of these methods proved unsuccessful another approach was required. The data was successfully analysed using NVivo to break down the data into workable sections and then statements made in each section were coded and compared.

At this point in the research project it was identified that an international comparison would be useful to assess whether there was any good practice internationally that could inform the proposals for curriculum design.

After careful consideration of countries that may be able to offer any good practice and the feasibility of undertaking interviews was assessed, Australia was chosen. The same interview questions were used for eight interviews undertaken with the programme leaders of accredited construction management programmes in Australian universities.

The Australian data was analysed using the same methods as the UK data to assess any aspects of good practice. The findings from both countries were then compared.

As both qualitative and quantitative techniques were used to collect and analyse data, this supports the mixed model methodology approach. Details of the population samples, question development, method of analysis and results of the analysis are given in detail in chapter 5 The results from phase 1 and 2 were used to develop the curriculum design model.

3.4.3 Industry data

Initially it was decided that asking for industrial opinions on the developed curriculum model would be the best way of testing the model. A questionnaire was designed and this was going to be sent to a significant sample of Chartered Institute of Building members on line via an email link. The questionnaire was piloted with industry practitioners who also work in human resources and graduate training. Twenty eight responses were received and analysis using calculation of means and modal values only was undertaken due to the low number of responses in the pilot study. The pilot aimed to identify problems with the questions and make changes before it was sent out to the larger sample. However the results of the pilot were very disappointing.

The respondents contradicted themselves in questions and reverse questions, appeared to have little or no knowledge of curriculum design and had a very superficial knowledge of sustainable construction and design. It was decided that because of these issues, testing the model in this way would not produce any valid results because the planned larger sample would be potentially be less knowledgeable because they would not have the graduate training experience.

3.4.4 Phase 3

After conducting a literature review to identify a potential method for testing the model, a justified approach was to design a small scale intervention, in the form of a project based on the model, and then to pre and post test student knowledge and attitudes. This approach was adopted and supplemented by the use of a mid project questionnaire and also the collection of qualitative data to enable the student participants to provide richer data.

Three questionnaires were sent out electronically: before the project started, mid way through and after it was completed. Some of the questions were designed to identify variables to enable statistical analysis of the data to be undertaken and the other questions were designed to identify changes in awareness, knowledge, changes in attitude and changes to views on learning in the students. The questionnaire was piloted by using LJMU staff. After the data was collected it was imported into SPSS and statistical testing carried out.

Qualitative data in the form of student essays was collected a week after the project was completed to allow students to reflect on the processes undertaken, but not far enough away for them to have forgotten the key learning experiences. The students were asked to describe their increase in knowledge, change in attitudes and views on successful learning techniques. This data was used to try to clarify and/or explain trends in the questionnaire responses.

As both qualitative and quantitative techniques were used to collect and analyse date, this supports the mixed model methodology approach. Details of the population samples, question development, method of analysis and results of the analysis are given in detail in chapter 7.0

3.5 Conclusions

The use of a mixed model methodology approach to data collection and analysis has been validated for this research project as it is deemed to be useable in both built environment and educational research projects.

In the three main phases of data collection both qualitative and quantitative data has been collected and analysed separately and complementarily. Phase 1 justified the need for the research and enabled techniques for the collection of richer data to be developed. The findings of phase 2 enabled the curriculum design model to be developed and phase 3 focussed on the testing of the model.

4.0 Phase 1- Existing National Picture

4.1 Introduction

The following, were the objectives of the phase 1 data collection:

1. To gain insight into present curricular situation concerning the environment, and the stakeholders' own evaluation of that situation
2. To gain insight into students' concepts and understanding of the environment
3. To identify principles for greening of curricula by staff- this objective will be achieved through discussions with programme leaders
4. To identify industry attitudes to sustainability in the context of construction and buildings, assess how proactive industry is in changing practices and what the drivers are that would encourage changes in practice.

4.1.1 Educational Data Sample

There are elements of qualitative data collection and elements of quantitative data collection that are required in order to achieve these objectives.

Phase 1 involved the collection of data from industry and HEIs in the UK. The educational primary data collection was collected from students (by questionnaire) and programmes leaders (through structured interviews) of programmes accredited by the CIOB under function D (Construction Management) at UK Universities. At the time there were 27 HEIs that satisfied the criteria, including the author's employer. A total of 22 programme leaders from the other 26 HEIs agreed to be interviewed and 15 returned student questionnaires.

Table 4.1 shows the total number of interviews held and questionnaires received from each region.

	Interviews			Questionnaires		
Region	**Possible number of Institutions**	**Interviews undertaken**	**Percentage**	**Possible number of Institutions**	**HEIs that returned student questionnaires**	**Percentage**
Scotland & NI	6	5	83%	6	2	33%
North West	4	4	100%	4	2	50%
North East	2	2	100%	2	1	50%
Midlands	4	3	75%	4	2	50%
South West & Wales	4	4	100%	4	4	100%
South East	6	4	66%	6	4	66%
Total	26	22	85%	26	13	50%
Total number received of questionnaires received was 142 from an expected 196 (72%)						

Table 4.1 Geographical Response Rates for Interviews and Questionnaire Returns

4.1.2 Industry Data Sample

The industry data was collected from Local Authorities in England and Wales. The Local Authorities were chosen as a subject for this part of the research as they act as both client and contractor for major building works. They are major clients for publicly funded construction work and it was assumed that they would have advanced environmental policies and procedures since the adoption of Local Agenda 21 strategies had become prevalent. The method chosen for the collection of the data was via the use of questionnaires and as there is relatively little competition between Local Authorities, the results should not be tainted because of fear of other authorities gaining a competitive advantage if results became public. It was also assumed that a high response rate would be achieved, and a large bank of data would be collected relatively quickly.

Questionnaires were sent out to 102 Local Authorities in England and Wales. Of the 102 questionnaires sent, 73 were returned indicating a response rate of just under 72%.

4.2 Research Methodology and Design

4.2.1 Education Sector

For this section the total population of the Universities based in the United Kingdom that run undergraduate programmes in Construction Management that are accredited by the Chartered Institute of Building under function D of their educational framework were approached to assess their willingness to participate in the survey. There are 27 Universities that satisfied the criteria at the time, however Liverpool JMU was excluded from the sample to be contacted as the author held the programme leader role at the time that the interviews were undertaken. However the student questionnaire was piloted at LJMU and changes were made to the questionnaire after the pilot study (see appendices for the changes and final questionnaire). The author believed that the student responses to the new questionnaire would be tainted because it would be the second time the students had been asked to complete it.

The methodology for exploring the educational aspects of the study was derived from some of the principles used by Wemmenhove and de Groot (2001), and although there are significant differences between their work and the work of this project, the method has produced results that are entirely feasible. Wemmenhove and de Groot were investigating how the curricula of an entire University could be 'greened' as opposed to this study which is investigating how the curricula of a very small number of programmes can be greened. This approach should allow for data richness (the qualitative element) and also representativeness (the quantitative element) as identified by Wemmenhove and de Groot.

4.2.2 Questionnaire Design- Structured Interview

Dorweiler and Yakhou (1998) utilised a survey in their research into how environmental issues are taught to non-environmental students. The survey consisted of open ended questions in four specific areas:

- Background information on the type of school and discipline approach
- Extent of environmental research programmes
- Whether the School offered environmental courses
- The extent to which environmental courses/modules were offered outside the environmental programmes.

- Need to design/adapt and pilot.

This approach was used in the design of the questions to be asked to programmes leaders that are given in the appendices.

4.2.3 Questionnaire Design -Student Knowledge

The knowledge that students gain overtly was investigated by the use of questionnaires issued to final year students studying on relevant courses to assess their knowledge. The questions concentrate on drawing out the deep learning that the students have acquired through their studies and are based on the research undertaken by Tikka et al (2000) that aimed to identify student attitudes to the environment by comparing students from a variety of educational establishments. Their objective was to determine whether there were significant connections between a) students' attitudes to the environment, b) their willingness to participate in environment related activities, c) their knowledge of current environmental problems. They realised that education is only one of the factors that contribute to learning but tried to discover whether the educational background and place of education affected attitudes and knowledge.

Their research found that the students with the worst attitude to the environment were engineering students and vocational school students, which is significant as these are the students who will eventually go on to work in industries that have the most impact on the environment. Another significant finding was that in all three areas women fared much better than men, which does not bode well for industries that are still male dominated such as construction.

Gigliotti (1992) explained that the negative attitudes of engineering students was due to the fact that students were unwilling to make personal sacrifices in favour of the environment because they trusted the capability of technology to solve environmental problems.

The main variable in the research carried out by Tikka et al (2000) was the effect of students' background on the responses given. The children of farmers, foresters etc. were much more positive than the children of entrepreneurs and therefore the conclusions formed were that gender, age and background had an effect on environmental attitude. However although it cannot be claimed that educational institutions are completely responsible for forming attitudes, they believe that the role of the educational field is a significant one. The investigation into student background and the effect it has on environmental attitude is beyond the scope of this research, but the depth of learning and the influence of that learning on attitude and further behaviour can be analysed to a certain extent using the questionnaire. The only aspect of student background that is identified from the questionnaire is whether the students are full time, part time or sandwich students. Any difference in responses from these groups will require explanation.

The methodology adopted by Tikka et al (2001) to gain an understanding of how students' environmental knowledge and environmental attitude have improved through their studies is by questionnaire. The methodology was adapted from the work carried out by Campbell Bradley et al (1999). In their work the subjects were high school students who were assessed before and after exposure to a 10 day environmental science course, although the situations are different in this study- undergraduate students on the final year of their studies, the methodology is still relevant.

Fien and Rawling (1996) identify in their module design for evaluating and research in environmental education, that there are three major traditions in research in environmental education: experimental and survey research, ethnography and critical action research. The method used is survey research and therefore valid to the subject area.

The bulk of the questions are written utilising the Likert scale method. This type of scale is concerned with determining respondents degrees of agreement or disagreement with a statement on usually a 5 or 7 point scale (Fellows and Liu, 1997). By using an odd number of response points, respondents may be tempted to opt out of answering by selecting the mid point. Hence the use of a 4 point scale as it will have no central point for questions where a response is required for some of the questions.

The initial questionnaire was piloted with students at Liverpool JMU (22 out of 25 possible respondents) and this piloting process identified a number of flaws. A summary of changes made, the reasons for the change and the aim of the questions is given in the appendices.

The questions that identify students real understanding of sustainable construction methods and materials (Q4) is based on the Environmental Preference Method developed by Woon/Energie (Anink et al, 1996), which allows for the student to rank different elements of construction according to their environmental quality.

4.2.4 Questionnaire Design – Industry Sector

The questions were designed to assess whether Local Authorities have a Local Agenda 21 policy, if they do whether it is actually implemented, willingness to pay for improved environmental performance in construction works, the understanding of sustainable construction and identify the role that universities can have in the education of Local Authority employees.

The questionnaire was designed to mix dichotomous and scaled questions to allow quantitative analysis. Certain questions allowed for a qualitative reply if the respondent felt they wanted to add anything. The scaled questions used a Likert Scale, this allowed a qualitative response, a cognitive attitude statement, to be used as a quantitative variable for analysis (Oppenheim,1992).

4.3 Data analysis

4.3.1 Educational Data

The following statistical methods were used to analyse the data:

1. Responses standardised, normalised and presented using comparative descriptive statistics.

2. Arithmetic means or modes calculated, along with the standard deviation.

3. The two sample Chi-square test has been used for some elements to assess if two or more variables are associated to a significant level, using a 5% level of significance which is a standard value.

The reason for the choice of the chi-square test is that it allows data to be tested to see if there is any statistically significant difference between groups of respondents classified under different variables. Chi-square is a non-parametric statistical test (sometimes called distribution free statistics) that is used when parametric tests are not suitable. Parametric tests assume that the data set has certain characteristics, i.e. the means will be similar for each set of data and/or the data follows a normal distribution pattern. When these conditions are not met with the data set, non-parametric tests need to be used. The use of nonparametric tests allows the analysis of data that comes as frequencies (Salkind, 2004). For example the students who responded to the questionnaire can be classified as either low research or high research. This depended upon how the programme leader responded to the series 4 questions on their list of questions that relate to level of research activity in the particular University and how well that research feeds into teaching. The chi-square test is then used to test the null hypothesis. The null hypothesis in this case would be that there will be no difference between the responses given by both groups for the same question. If the chi-square test results in an acceptance of the null hypothesis then there is no difference between the responses from the students classified as low research than those classified as high research. If the test rejects the null hypothesis then there is a statistically significant difference.

4. The one and two sample Z tests

A Z- score is a standard score that is calculated by dividing the amount that a raw score differs from the mean of the distribution by the standard deviation. These scores are used when working with distributions that are different and yet the need to compare them with one another is required. Standard scores are comparable because they are standardised in units of standard deviations. Using knowledge of normal curve distributions, a Z score represents a raw score and also a location along the x axis of a distribution curve. The more extreme the Z score, the further it is from the mean and therefore the more likely it is that the null hypothesis is rejected and there is a statistically significant difference in the responses given by two groups.

4.3.2 General questions aimed to assess the validity of the sample

All the programme leaders are involved in the design of the curriculum for the Construction Management programme and all the programmes had been validated within the last five years. Only one respondent stated that they had made significant changes regarding environmental/sustainability issues.
The sample for the choice of programmes is therefore valid, and all the programme leaders were able to comment on the curriculum, its relationship to the CIOB framework, and as 21 of the 22 had not made any significant changes to the programme it is assumed that there has been no reaction to the increased environmental debate since their validation. All the students were studying the final year of a CIOB accredited Construction Management programme.

4.3.3 Analysis of responses by question

Question: Do any of the aims and/or objectives of the programme make specific reference to the environment/sustainability?

The response from the programme leaders was: Yes- 10, No-12.

To assess whether the students on programmes that had a clearly stated programme aim, perceived that they had a greater level of awareness of environmental issues, the student questionnaire asked students to identify with their level of awareness. The responses and analysis are shown in the CHISQ1 in the appendices.

As the null hypothesis has been accepted it is evident that there was no significant difference in the awareness of students to environmental issues if the programme has a specific environmentally focussed learning outcome.

Question: Do any modules have learning outcomes that make specific reference to the environment/sustainability?

The question was asked to ascertain whether student perception of how much environmental content there was in the programme, agreed with the programme leaders perceptions. The programme leaders stated the following to the question: Yes=19 therefore the majority (84%) and No=3

The response to a percentage value of time given to this area ranged from 10-25%, the mean being 16%.

The hypothesis for this aspect was: Student perception of the amount of environmental inclusion of the course overall, tallies with programme leader perception

The student question posed was: Approximately how much of your programme of study has included environmental/sustainability issues under the listed headings?

The responses for the whole sample are given in table 4.2

	Modules	**Lectures**	**Assessment**	**Group Based Projects**	**Practical Work**
100%	4	2	1	2	1
75%	21	18	10	18	9
50%	38	40	41	38	18
25%	73	87	80	60	51
0%	16	6	21	35	68
Total response	152	153	153	153	147
Arithmetic Mean(%)	57	57.25	49	49.5	29.5
Mode	25%	25%	25%	25%	0%

Table 4.2 Student perception of environmental content of their programme

It can be seen from the mean figures obtained from the student response that students perception of environmental content overall is far greater than that of the programme leaders, illustrating that there is an 'informal' inclusion of environmental issues in the 'formal' programme which is not immediately apparent to the programme leaders.

Question: In which modules/units are environmental issues included?

The number of times each main subject was mentioned in the interviews are shown in chart 4.1

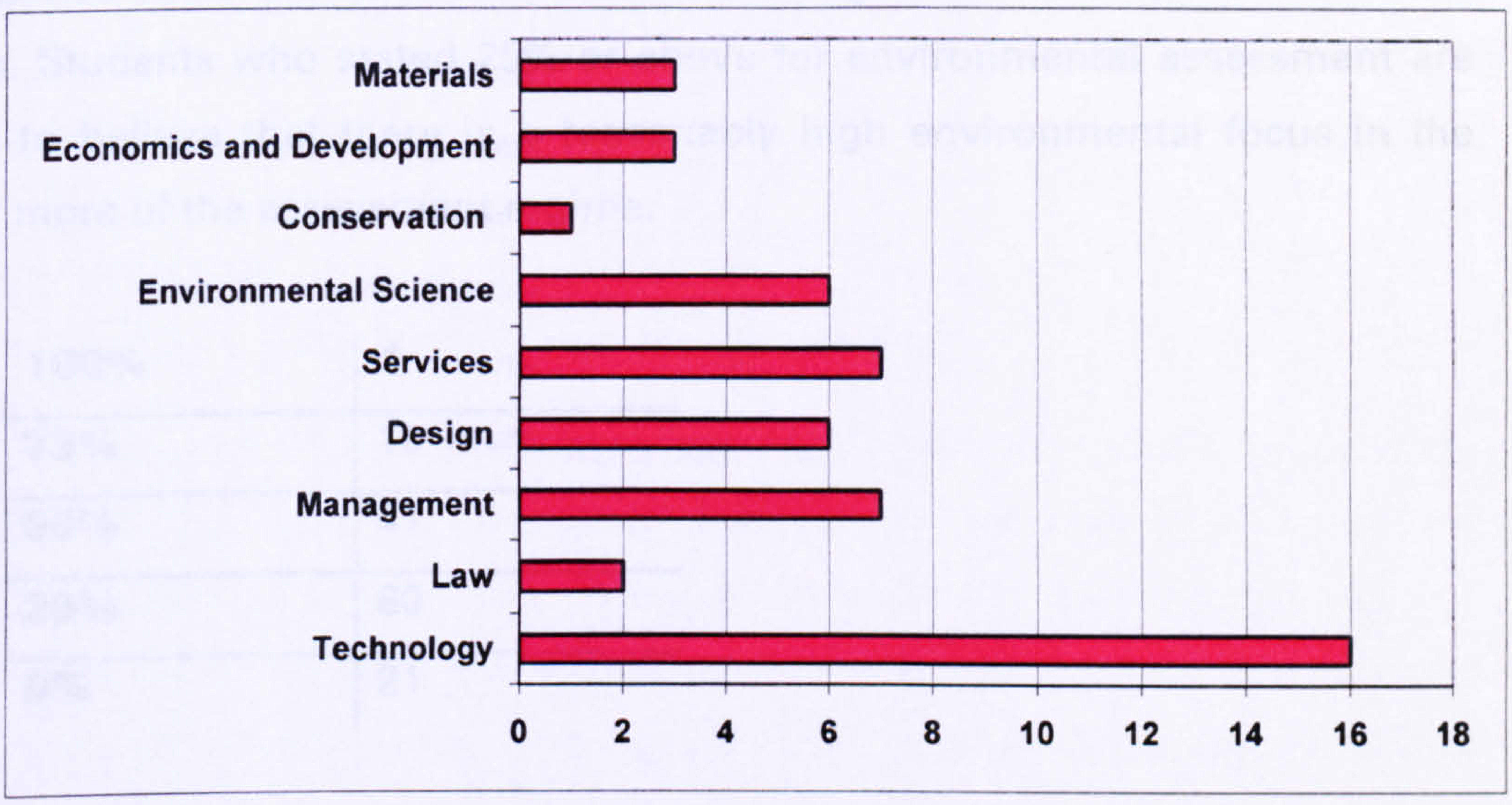


Chart 4.1 Programme leader perception of where environmental issues are included

It can be seen that sustainability and environmental issues are most commonly developed in technology subjects as opposed to management. Grouping technology, design, services, conservation and materials gives a total of 33, whilst grouping law, management, economics and development gives a total of 12. Environmental science by the nature of its title will have learning outcomes linked to the environment, but this subject may not include any issues relating to sustainability of systems used in the construction process, usually the focus is on scientific principles related to environmental comfort.

An interesting response that has not been included in the table is the approach that one institution takes for level one students. The students study Information Technology and in order to develop interest in the module, all the assessments are carried out using Information Technology. The tasks themselves have an environmental focus, which leads to an integrated approach to the delivery of environmental issues whilst not detracting from the requirements of the programme to develop student transferable skills.

Question: Are there any modules in the programme where the focus is predominantly environmental issues?

The response rates are shown in table 4.3 along with the response rates for students. Students who stated 25% or above for environmental assessment are deemed to believe that there is a reasonably high environmental focus in the some or more of the assessment regime.

100%	**1**
75%	10
50%	41
25%	80
0%	21

Table 4.3 Figures for assessment-total sample

After analysing these figures using the one and two sample Z tests (Z-Test 2 in the appendices), it is evident that the average percentage of overall assessment that has an environmental focus is assumed by students to be 32% which is significantly higher than that perceived by the programme leader of 16%.

Question: Does your school or department promote interdisciplinary education, and if so what form did this take?

The responses are shown in table 4.4

Yes, lectures only	1
Yes, lectures and projects	18
No- don't want to	2
No-due to nature of programme	1

Table 4.4 Interdisciplinary education responses

The subjects groups that work most closely with construction management are building surveying, quantity surveying, architectural technology and building services engineering and to a lesser extent architecture and civil engineering.
These figures would indicate that HE institutions are practising the proposals of the Egan Report (1998), which recommends that built environment disciplines work more closely together, in order to improve the performance of the construction industry. However the number of institutions that had embraced these developments enthusiastically are few, and the majority stated that they had only gone down this route because:

a. They felt that HE had a responsibility to lead the way and had done so by developing multi disciplinary projects, especially in the final year.
b. Due to declining staff numbers, and to a certain extent student numbers, the teaching of large groups of students on different courses was the only cost effective mode of delivery.

Therefore 'cross disciplinary education' is occurring not because of its potential benefits for the industry in the long term, but merely as a cost saving exercise. However when programme leaders were asked what they believed was the best assessment approach to develop student understanding of environmental issues, that can ultimately change attitudes and then the behaviour of the individuals to improve the behaviour of the industry the responses were as shown in table 4.5

Projects	3
Group work and interdisciplinary group work	9
Case Studies	4
Problem based learning	2
Coursework	4

Table 4.5 Assessment Approaches

These figures indicate that although programme leaders are sceptical about the success of interdisciplinary education from a logistical perspective, they do see the value.

However, the student response to the amount of environmental content of group based projects indicates that this type of project is not utilised fully to develop understanding as evidenced by the responses given to the amount of environmental content in group based projects, shown in table 4.6

100%	2
75%	18
50%	38
25%	60
0%	35

Table 4.6 Student figures for environmental focus of group based projects-total sample.

Therefore the hypothesis that, given programme leaders' perspectives, group based interdisciplinary projects have a strong environmental focus is to a certain extent proved false as 68% of students stated a relatively low inclusion of environmental issues in group based projects. After analysing this data using the one sample Z test, (Z-Test 1 in the appendices) the figures show a wide variation in student perception for the variable in question. The mean value of 32% confirms the observation that student perception of the level of environmental focus in group work projects is low, which contradicts with the programme leaders perception that this is the best way to improve environmental learning.

Indeed referring to table 4.3, student perceptions indicate that environmental issues are included more in modules, lectures and other forms of assessment than in group based projects.

Question: Do you think that the CIOB framework puts enough emphasis of environmental issues?

4 responded yes and 18 responded no.

The courses are all validated by the CIOB under the same educational framework and there is a clear statement in the framework concerning the importance of incorporating environmental issues. It was commented on by a number of programme leaders that although it did state this, there was not enough room in the curriculum to put more environmental content in because of all the other topics that needed to be covered. One institution responded that the accreditation panel had specifically stated that they wanted no more environmental content to be included as it was distracting away from the main theme of the programme. Programme leaders were also asked if they adopted an integrated (which is the way the CIOB framework promotes its delivery) or fragmented approach to teaching environmental issues of the programme. The response was fragmented-13 and integrated-9.

Considering that all the programmes are accredited by CIOB which clearly states that an integrated approach should be adopted, these figures are surprising, and would indicate that the framework can be interpreted differently by different institutions and different visiting accrediting panels.

Question: At what level/stage of study is the concept of sustainability introduced and how does it develop through the programme?

The responses to when sustainability is introduced in the programme are as follows: Level 1-15 responses, Level 2-6 responses, Level 3 of 4(Scottish University)-1 response. As the majority of respondents had stated that sustainability was predominantly introduced in technology based modules, these responses were surprising. Technology is a major element of the CIOB educational framework core studies programme(level 1) and therefore it was expected that the programmes would all introduce the concepts in level 1, yet 32% of the institutions do not introduce it until level 2.

Programme leaders response to whether the concentration increases through the levels were as follows, increase-10 responses, decreases-3 responses and remains constant-9 responses. The respondents who stated that their concentration increased or remained constant generally identified that their curriculum introduces concepts and fundamentals in level 1, applies them in level 2 and allows for specialism in level 3.

The CIOB educational framework of 1994 did not promote this type of approach, but the 2002 and 2007 models do, and would illustrate that the HEI practice between 1994 and 2001, and 2002 and 2006 has had an influence on the frameworks.

Question: How willing would you be to increase the amount of environmental content in the programme?

It was put to programme leaders that the proposed 2002 framework was supposed to be more flexible than the 1994 framework. If this was the case would they consider increasing the amount of environmental studies in their programme. 14 stated yes, whilst 8 stated no, they already had enough. A comparison of the perception of students as to how much environmental content there is in modules on the programme has been undertaken. The hypothesis being that programmes where the programme leader stated they would include more, would have a lower environmental content in modules, than those who stated they would not include more as they had enough in already. Table 4.7 contains the data and analysis for this question.

Observed frequencies:

	Would include more	Wouldn't include more	Totals
100+75%	20	5	25
50%	17	21	38
25%	36	37	73
0%	2	14	16
Totals	75	77	152

Expected frequencies:

	Would include more	Wouldn't include more	Totals
100+75%	12 33552632	12 66447368	25
50%	18 75	19 25	38
25%	36 01973684	36 98026316	73
0%	7.894736842	8.105263158	16
Totals	75	77	152

Chi Square Components:

	Would include more	Wouldn't include more
100+75%	4.762192982	4 638499658
50%	0 163333333	0.159090909
25%	1 08147E-05	1 05338E-05
0%	4 401403509	4 28708134

Note: Due to the low expected frequencies for the
100% and 75% categories, they have been combined

Obtained Value of Chi Square =	**18.41162**
Degrees of Freedom =	**3**
Critical Value of Chi Square (5%) =	**7.8**
Decision:	**Reject the Null Hypothesis**

Table 4.7 Chi Square Test- responses to increasing environmental content question

The null hypothesis has been rejected and this illustrates that there is a statistically significant difference in the perception of students as to the amount of module content that focuses on environmental issues between institutions that believe they need more, compared to those that believe they already have enough. It does illustrate that some institutions therefore place more emphasis in this area.

As an addendum to the previous question, programme leaders who stated they would include more environmental issues, were asked if they would have to 'lose' anything from the curriculum in order to accommodate the changes. Two respondents stated that if they had to lose anything it would be the heavy mathematics, structures and materials modules, but all respondents stated they would prefer not to lose anything, but opt for a more integrated approach to delivery. The benefits of an integrated curriculum were therefore clearly understood by all respondents in this group.

Research Ratings

Programme leaders were asked what the RAE rating for their department in the 2001 assessment was, how much of the research carried out in their school or department was related to construction management, and how much of the research had an environmental focus. The reasons for this were twofold.

To establish which institutions have a high level of research being undertaken that may feed into the programme, and to classify those programmes so that the data generated by the students of these institutions can be compared to the data generated by students classified as low research. A high RAE rating, and/or high percentages of research that concentrate on construction management and environmental issues are classed as high research.

The responses are shown below in table 4.8

Research Rating	
5*	2
5	2
4	1
4a	1
4e	1
3a	5
3b	3
3d	1
2b	2
Non submission	3

Table 4.8 RAE ratings of universities involved in phase 1

Therefore 7 of the 22 institutions would receive significant funding for research over the next five years (2002-2007).

Question: How much of the input to the assessment exercise was related to construction management?

% -100, 10, 30, 25, 70, 5, 5, 20, 5, 70 ,90, 5, 5, 5, 11, 30, 30, 0, 0

Arithmetic Mean=27.2%

Standard Deviation= 30.76

Coefficient of Variability= 113%

Question: Approximately, how much of the research carried out by members of your section/faculty/school has an environmental focus?

%- 25, 60, 0, 5, 85, 0, 20, 13, 13, 20, 30, 40, 10, 5, 50, 90, 20, 90, 5, 25, 50, 0

Mean= 29.6%

Standard Deviation= 28.3

Coefficient of Variability= 96.6%

These figures indicate that there is a vast difference in the amount of research being undertaken in the sustainable construction management field, but there is marginally more correlation between the amounts of environmental research than construction management research focussed in other areas.

The mean values were used to estimate very approximately how much research is being undertaken in sustainable construction management practices, 29.82% of 25.57=7.62%. This very rough figure illustrates that the level of construction management research with an environmental focus are low, but there are pockets of very specialised high level research in this area. Indeed three of the top RAE rated institutions reported higher levels than the general figure:

The responses given indicate that approximately 20% of research being undertaken in the top rated research departments for built environment disciplines, is related to sustainable construction issues.

Question: What influence does research have on student knowledge in your department?

The programme leaders at 17 of the institutions stated that research fed into teaching. The data generated from students to assess their knowledge of sustainable construction technologies and sustainable construction management procedures has been divided into two groups.

High Research = those institutions with a high RAE rating, those with a high level of research undertaken in their School that has an environmental focus.

Low research = those institutions with a low RAE rating, those with a low level of research undertaken in their School that has an environmental focus, and those who stated that research findings did not feed into teaching.

The hypothesis to be tested is: Students studying at a high research rated institution where research findings feed into teaching will be more knowledgeable on environmental technologies and management than those studying at a low rated research institution.

Student knowledge of sustainable technologies

Students were asked to rate the materials or systems listed in table 4.9 from 1-5(1 being very damaging, 5 being very good environmentally). The correct answer is marked *

UPVc	**Photovoltaic cells**	**Concrete**	**Clay Drain Pipes**	**Refurbishment**
Very Damaging *	Very Damaging	Very Damaging*	Very Damaging	Very Damaging
Damaging	Damaging *	Damaging	Damaging	Damaging
Average	Average	Average	Average	Average
Good	Good	Good	Good	Good *
Very Good	Very Good	Very Good	Very Good *	Very Good

Table 4. 9 Likert scale for assessing student knowledge of technology

The responses and the analysis to compare whether there is a difference between the knowledge of students at high research rated institutions and those at low research rated institutions are shown in tables –CHISQuPVC, CHISQPVcells, CHISQconcrete, CHISQclay pipes and CHISQrefurb in the appendices.

The null hypothesis was accepted for all cases illustrating that there is no statistically significant difference between the student knowledge of technical environmental issues between low and high rated institutions.

However this analysis does not illustrate the level of student knowledge. Chart 4.2 shows a comparison of the results attained. The responses have been standardised and normalised, and can be compared with the values had the question been answered 100% correctly

UPVC	PV Cells	Concrete	Clay Pipes	Refurbishment
CV=1	CV=0.75	CV=1	CV=0	CV=0.25
Difference= 0.3	Difference=0.45	Difference=0.4	Difference=0.5	Difference= 0.15

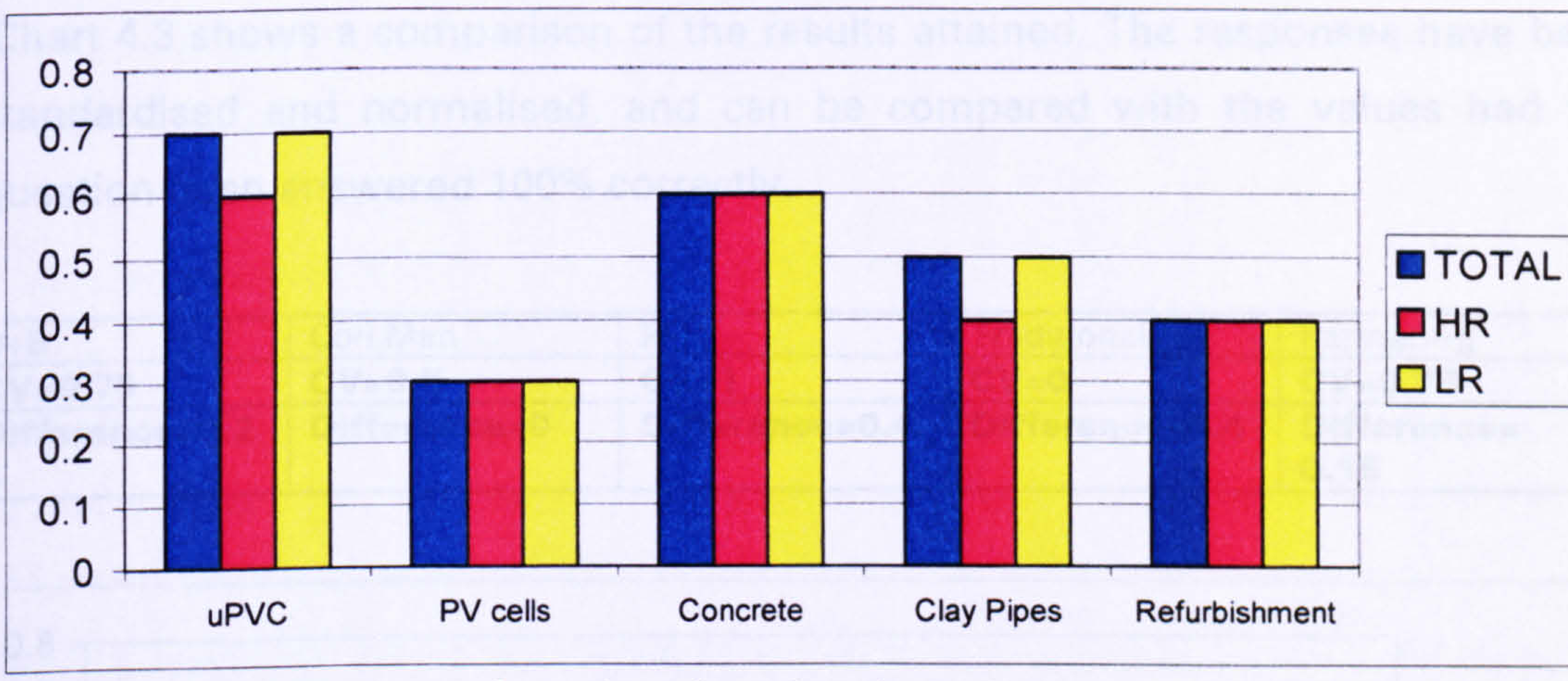


Chart 4.2 Comparison of results of student knowledge

The figures derived from the chart identify that there is an average of 36% error in the assumption of students as to the damaging effects of technologies on the environment. These figures will be compared against those gathered in order to assess knowledge of management issues related to construction.

Student knowledge of the impact of different procurement methods on sustainability

Students were asked to rate the methods listed in table 4.10 from 1-5(1 being very good at promoting sustainable construction, 5 being very poor). The correct answer derived from the literature review is marked *

Design and Build	Construction Management	PFI	Traditional	Partnering
Most Effective	Most Effective	Most Effective *	Most Effective	Most Effective
Effective *	Effective	Effective	Effective	Effective *
Average	Average *	Average	Average	Average
Not Effective	Not Effective	Not Effective	Not Effective	Not Effective
Very Un-effective	Very Un-effective	Very Un-effective	Very Un-effective *	Very Un-effective

Table 4.10 Likert scale for assessing student knowledge of procurement

The responses and the analysis to compare whether there is a difference between the knowledge of students at high research rated institutions and those at low research rated institutions is shown in CHISQPROC in the appendices. As the null hypothesis was accepted in all cases this would indicate that there is no statistically significant difference in the knowledge of students at high research ranked universities than those at low ranked.

Chart 4.3 shows a comparison of the results attained. The responses have been standardised and normalised, and can be compared with the values had the question been answered 100% correctly.

D+B	Con.Man.	PFI	Traditional	Partnering
CV=0.75	**CV=0.5**	**CV=1**	**CV=0**	**CV=0.75**
Difference=0.25	**Difference=0**	**Difference=0.4**	**Difference=0.4**	**Difference=0.15**

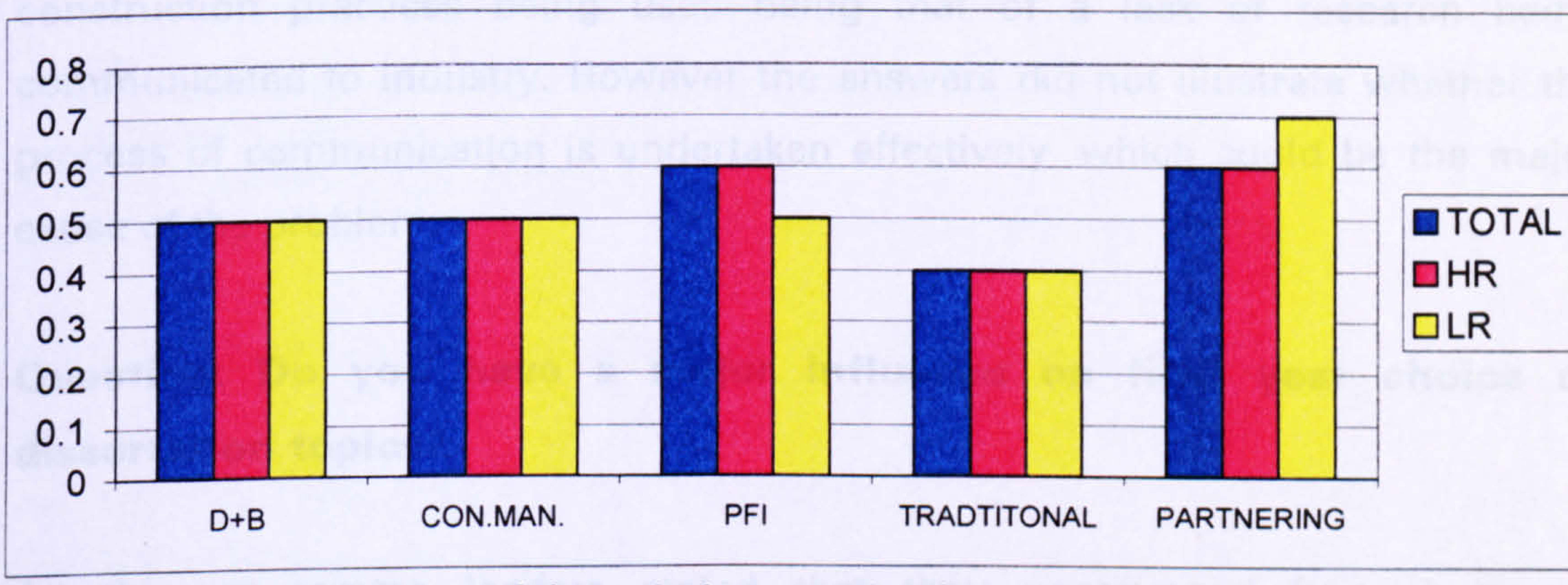


Chart 4.3 Comparison of knowledge results between high research and low research ranked universities

The figures derived from the chart identify that there is an average of 24% error in the assumption of students as to the most effective procurement routes in promoting sustainable construction.

Comparing the errors for this set of data (24%) and those for sustainable technologies (36%) it would appear that students are more knowledgeable about management issues surrounding construction as opposed to technical issues.

This conflicts with the response from programme leaders that the main subjects where sustainability and environmental issues are introduced are technology subjects. Students have either applied knowledge to the question asked well, or sustainability is being considered and discussed more in management modules than the programme leaders expected.

However as there is so little difference it is valid to state that there is no significant difference in student knowledge if a high level of sustainable construction research is being undertaken.

Question: Do you think that research findings are communicated to industry?

The response was Yes-11, No-7, Some-4.

Those with a high RAE rating and/or lot of sustainability research being undertaken (except for one institution) stated that research findings did feed into industry, which to a certain extent dispels one of the barriers to more sustainable construction practices being used being that of a lack of research being communicated to industry. However the answers did not illustrate whether the process of communication is undertaken effectively, which could be the major cause of the problem.

Question: Do you have a major influence on final year choice of dissertation topics?

All the programme leaders stated that they encouraged free choice of dissertation topic, although they would give advice if the student requested it. In total 29% of students are doing a dissertation with an environmental/sustainability focus, which illustrates that among the student body this is a popular topic, given the range of potential topics that could be chosen.

It was assumed that where there is a high level of research into sustainability and environmental issues, there would be greater staff expertise and more students would choose this area. The responses to the student question as to whether their dissertation topic contained the following words: sustainable, sustainability, environmental, green, energy efficiency, are shown in table 4.11, and analysis has been undertaken to assess whether there is any difference between high research rated institutions and low rated research institutions.

Observed frequencies:

	HR	LR	Totals
Yes	19	23	42
No	53	54	107
Totals	72	77	149

Expected frequencies:

	HR	LR	Totals
Yes	20.2953	21.7047	42
No	51.7047	55.2953	107
Totals	72	77	149

Chi Square Components:

	HR	LR
Yes	0.08267	0.077302
No	0.03245	0.030343

Obtained Value of Chi Square =	**0.222764**
Degrees of Freedom =	**1**
Critical Value of Chi Square (5%) =	**3.8**
Decision:	**Accept The Null Hypothesis**

Table 4.11 Analysis of Dissertation topic choice

As the null hypothesis has been accepted, there is no statistically significant difference between the two different groups and the type and level of research being undertaken by the university does not necessarily influence students choice.

Interestingly, 35% of full time and 36% of part time students are undertaking a dissertation with an environmental focus, but only 16% of sandwich students are. Many sandwich students undertake dissertation topics which they believe are relevant to the company they worked for during their industrial placements and as this figure is so low, it is possible that environmental factors were deemed to be of less importance to their employers than other subjects. As all the programme leaders stated that students were encouraged to develop their own interests in the dissertation, this could lead to the assumption that employers have more influence over choice of dissertation than academics, regardless of research rating.

Question: Do you have any examples of good practice relating to the teaching of environmental subjects?

The programme leaders were asked if they had any examples of good practice regarding the teaching of environmental subjects. 13 respondents stated no, and examples of responses by those who stated yes are:

- Using CIRIA resource packs
- Using the Television Educational Network packages
- Working with local builders/developers to build environmentally friendly buildings to be used as case studies by the students
- Group projects

Although there were not many examples, the responses illustrate the importance of working in groups on real life case study projects appears to be the perception of best practice amongst teaching staff.

Barriers that prevent more concentration on environmental issues within the curriculum

Programme leaders were asked if there were any reasons that prevented more inclusion of environmental aspects into the curriculum. The responses are illustrated in chart 4.4.

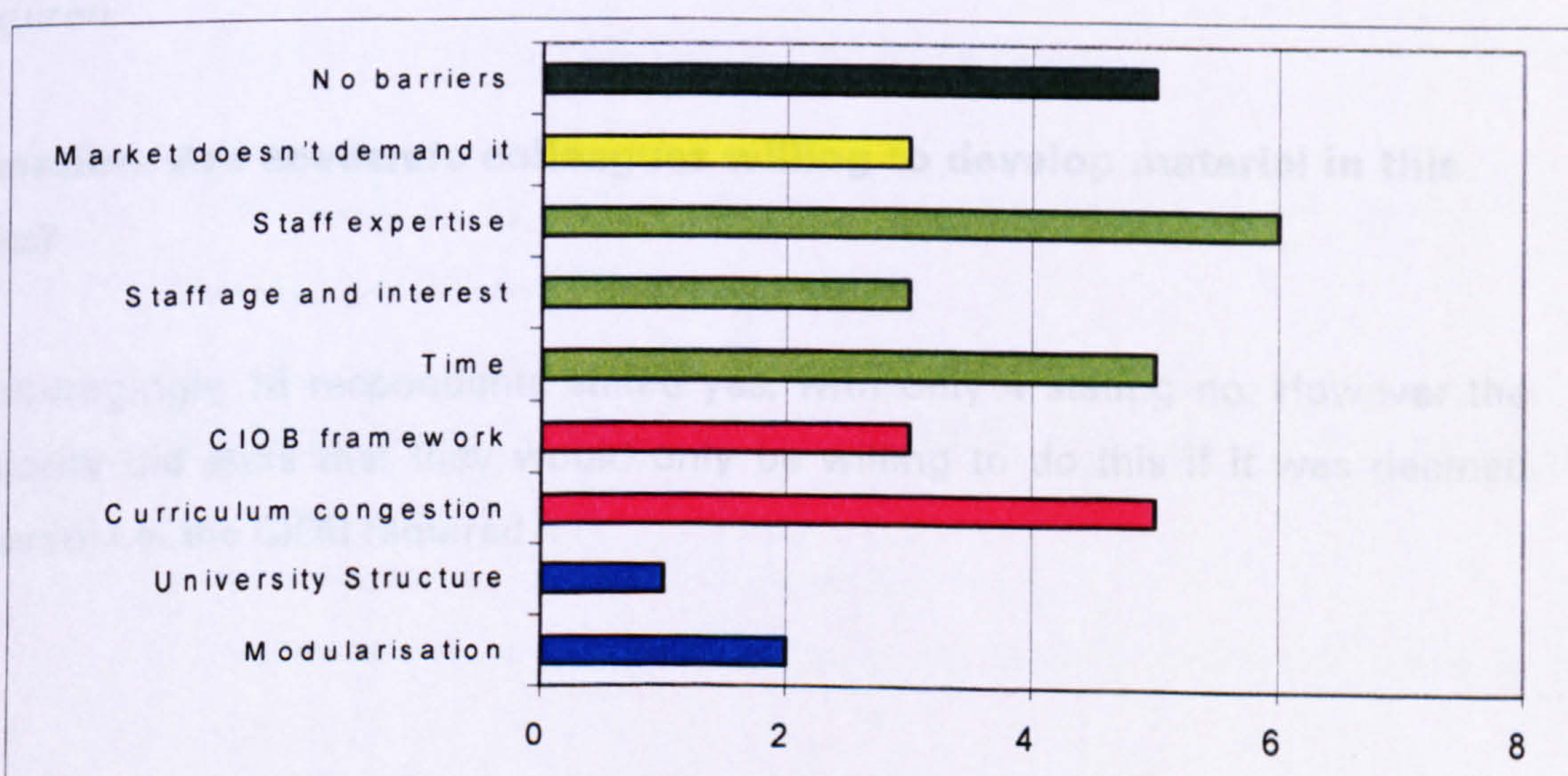


Chart 4.4 Barriers preventing more concentration on environmental issues

The literature review highlighted the following as barriers:

- Organisation and structure of UK HEIs
- Academic indifference and unwillingness to change
- The curriculum
- Student backgrounds
- Lack of communication between academia and industry.

The responses corroborate with these findings to some extent, the only aspect which was not mentioned by the programme leaders was student backgrounds, highlighting that potentially they do not see this as a barrier.

Grouping and ranking the responses illustrates that the major barrier is academic indifference and expertise which is linked to time available to develop. This is followed by curriculum issues and the restrictions imposed by the CIOB due to the amount of other topics to be included in an accredited programme. There were an equal number of responses stating that barriers were university organisations and structures and issues of communication to industry of the importance of sustainability in the curriculum and the fact that if industry does not require more in the curriculum, then there is no reason to include more.

However seven respondents stated there were no barriers, which illustrates that even if all of the barriers are present to some extent, they can be overcome if required.

Question: Are academic colleagues willing to develop material in this area?

Encouragingly 18 respondents stated yes, with only 4 stating no. However the majority did state that they would only be willing to do this if it was deemed relevant i.e. the CIOB required it

Question: Does your university have policies for protecting the environment (1) and including environmental issues in the curriculum(2)

The responses to this question are given in chart 4.5

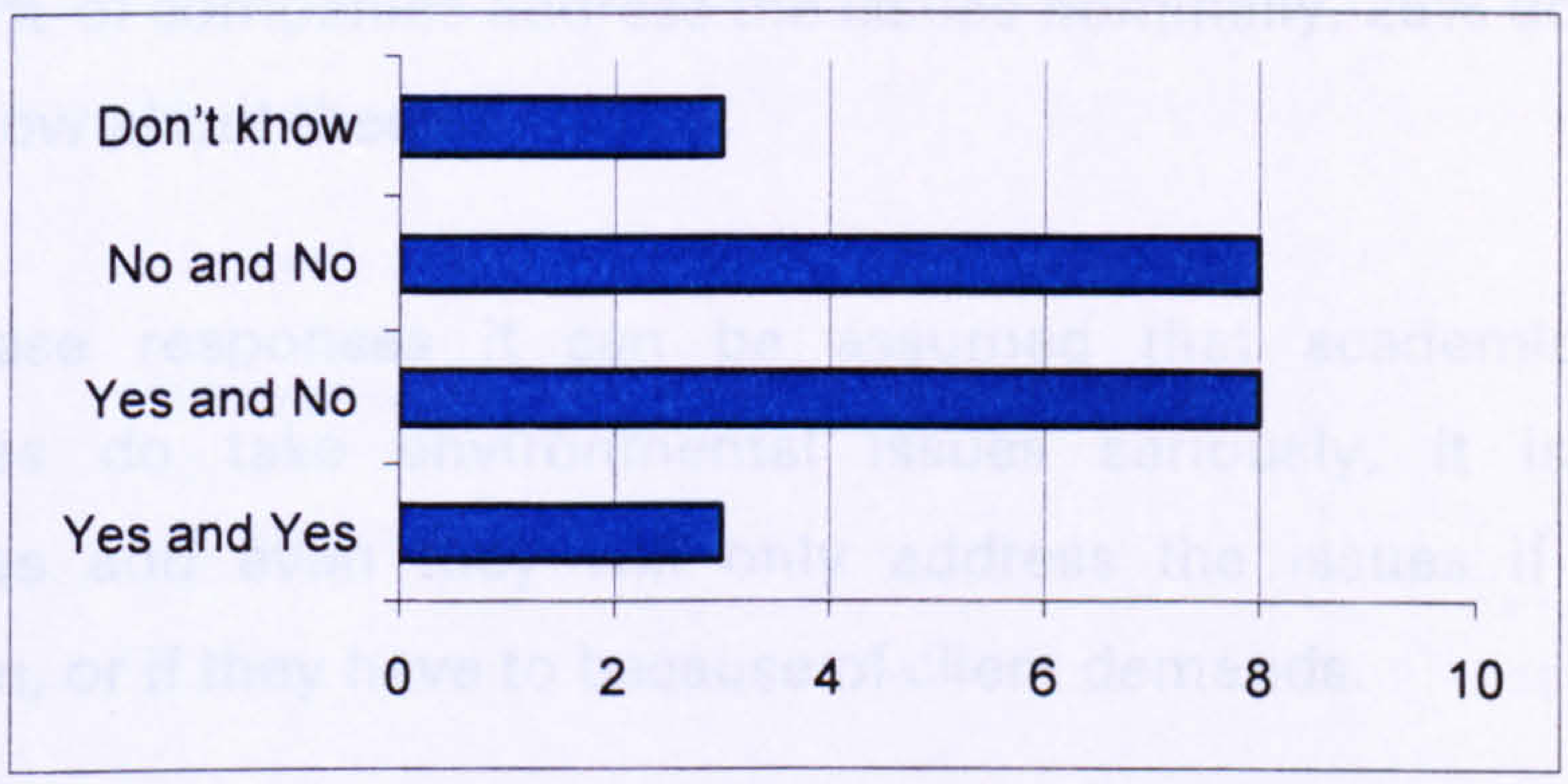


Chart 4.5 University policies for addressing the Toyne Report

One of the main aims of the Toyne Report (DFE(1993)), was that all universities should develop corporate environmental policies, and also promote greening of the curriculum. Twelve years on there is little evidence to support these initiatives. Only 3 of the 22 institutions have developed the recommendations of the report seriously in all aspects, 8 have a general environmental policy regarding the campus, travel, recycling of waste and energy efficiency, but 19 of the 22 stated that the university did not recommend the level of environmental content in the curriculum(those who stated "don't know" have been included in this figure, as it is assumed that if they are the programme leader and the university did set such criteria, then they would know about it)

Question: How seriously do you think that the construction industry takes sustainable construction issues?

The responses to this element were very negative. The responses were as follows:

- Industry does at senior management level-1
- The industry knows it is an issue, but is not willing to meet the cost of addressing it -5
- Industry only takes it seriously if pressed by clients to do so-2

- Companies have policies but do not comply with them to any great extent-2
- Only the big companies take it seriously-4
- Industry either takes environmental issues not very seriously, or not at all-7
- 50% of companies address the issues nominally, 25% don't, and 25% don't know about them-1

From these responses it can be assumed that academics believe that if companies do take environmental issues seriously, it is only the larger companies and even they will only address the issues if it improves their reputation, or if they have to because of client demands.

The student questionnaire posed the question, do you think that the industry does enough to protect the environment? The student responses were separated into three categories: full time, sandwich, and part time. It was assumed that the sandwich and part time students would support these opinions as they have experience of the industry. The responses and analysis are shown in CHISQ2 in the appendices.

The Chi-square test identifies that there is no significant statistical difference between the groups as the null hypothesis is accepted. However the actual percentage of full time students who believed that the industry does enough to protect the environment is 16 whilst only 10% of sandwich and part time students believe this to be the case. This illustrates that students with experience of the industry believe that it does not take environmental issues as seriously as those with no experience.

Question: Do you believe that the construction industry understands the impact that the built environment has on the environment, and do they prioritise environmental issues?

The responses were as follows:

Yes-1

Some-2

No-19

Again, this is fairly negative and identifies that programme leaders believe generally that the industry does not take the issues seriously and does not train staff to deal with the environmental debate to any great extent.

The students were asked to rate the following criteria from 1-5, 1 being the highest, as priorities which the construction industry takes seriously.

- Cost
- Time
- Quality
- Health and Safety
- Environmental issues

It was again assumed that there would be differences between the responses of full time, part time and sandwich students. However the only statistically significant difference in the results was for the quality and environmental issues sections where the null hypothesis was rejected as shown in tables 4.12, 4.13, 4.14, 4.15 and 4.16

Observed frequencies:

Cost	FT	SW&PT	Totals
VH	45	61	106
H	11	13	24
A+L	4	10	14
VL	5	3	8
Totals	65	87	152

Expected frequencies:

	FT	SW&PT	Totals
VH	45.32895	60.67105	106
H	10.26316	13.73684	24
A+L	5.986842	8.013158	14
VL	3.421053	4.578947	8
Totals	65	87	152

Chi Square Components:

	FT	SW&PT
VH	0.002387	0.001783
H	0.052901	0.039524
A+L	0.65937	0.492632

VL	0.728745	0.544465

A+L combined due to low expected frequencies

Obtained Value of Chi Square = **2.521808**

Degrees of Freedom = 3

Critical Value of Chi Square (5%) = **7.8**

Decision: **Accept The Null Hypothesis**

Table 412 Chi Square Analysis- Student perception of industry (Cost)

Observed frequencies:

Time	FT	SW&PT	Totals
VH	14	11	25
H	31	34	65
A	11	21	32
L+VL	9	21	30
Totals	65	87	152

Expected frequencies:

	FT	SW&PT	Totals
VH	10.69079	14.30921	25
H	27.79605	37.20395	65
A	13.68421	18.31579	32
L+VL	12.82895	17.17105	30
Totals	65	87	152

Chi Square Components:

	FT	SW&PT
VH	1.024328	0.765302
H	0.369307	0.275919
A	0.526518	0.393376
L+VL	1.142794	0.853811

L+VL combined due to low expected frequencies

Obtained Value of Chi Square = **5.351355**

Degrees of Freedom = 3

Critical Value of Chi Square (5%) = **7.8**

Decision: **Accept The Null Hypothesis**

Table 413 Chi Square Analysis- Student perception of industry (Time)

Observed frequencies:

Quality	FT	SW&PT	Totals
VH	5	8	13
H	8	26	34
A	29	33	62
L+VL	24	20	44
Totals	66	87	153

Expected frequencies:

	FT	SW&PT	Totals

VH	5.559211	7.440789	13
H	14.53947	19.46053	34
A	26.51316	35.48684	62
L+VL	18.81579	25.18421	44
Totals	65.42763	87.57237	153

Chi Square Components:

	FT	**SW&PT**
VH	0.056252	0.042027
H	2.941284	2.197511
A	0.233257	0.174273
L+VL	1.428377	1.067178

L+VL combined due to low expected frequencies

Obtained Value of Chi Square = **8.140158**

Degrees of Freedom = 3

Critical Value of Chi Square (5%) = **7.8**

Decision: **Reject the Null Hypothesis**

Table 414 Chi Square Analysis- Student perception of industry (Quality)

Observed frequencies:

H&S	**FT**	**SW&PT**	**Totals**
VH	6	16	22
H	11	16	27
A	24	24	48
L+VL	24	31	55
Totals	65	87	152

Expected frequencies:

	FT	**SW&PT**	**Totals**
VH	9.407895	12.59211	22
H	11.54605	15.45395	27
A	20.52632	27.47368	48
L+VL	23.51974	31.48026	55
Totals	65	87	152

Chi Square Components:

	FT	**SW&PT**
VH	1.234468	0.922304
H	0.025825	0.019294
A	0.587854	0.439201
L+VL	0.009807	0.007327

L+VL combined due to low expected frequencies

Obtained Value of Chi Square = **3.24608**

Degrees of Freedom = 3

Critical Value of Chi Square (5%) = **7.8**

Decision: **Accept The Null Hypothesis**

Table 4.15 Chi Square Analysis- Student perception of industry (Health and Safety)

Observed frequencies:

Env.Issues	FT	SW+PT	Totals
VH+H	10	4	14
A	2	7	9
L	4	12	16
VL	49	64	113
Totals	65	87	152

Expected frequencies:

	FT	SW+PT	Totals
VH+H	5.986842	8.013158	14
A	3.848684	5.151316	9
L	6.842105	9.157895	16
VL	48.32237	64.67763	113
Totals	65	87	152

Chi Square Components:

	FT	SW+PT
VH+H	2.690139	2.009874
A	0.888	0.663449
L	1.180567	0.882033
VL	0.009503	0.0071

Obtained Value of Chi Square = **8.330663**
Degrees of Freedom = 3
Critical Value of Chi Square (5%) = **7.8**
Decision: **Reject the Null Hypothesis**

Table 4.16 Chi Square Analysis- Student perception of industry (Environmental)

Students with experience of the construction industry appear to believe that industry considers environmental issues less than full time students who may be more ideological in their thinking. Chart 4.6 shows the standardised and normalised responses for each group, and illustrates that all students believe that environmental issues are the least rated criteria. Cost is most important, followed by time, then equally by quality and health and safety. Cost is believed to be the most important factor by the sandwich students, and this could be because their limited experience has not involved them in projects where environmental issues were deemed important by the client, and/or they have only worked for smaller contractors. The chart shows that overall the students who have the most experience of the industry (part time) rate cost as the highest factor, followed equally by time, quality and health and safety and finally environmental issues.

The data also confirms the perspectives of programme leaders who believe the industry places money before the protection of the environment.

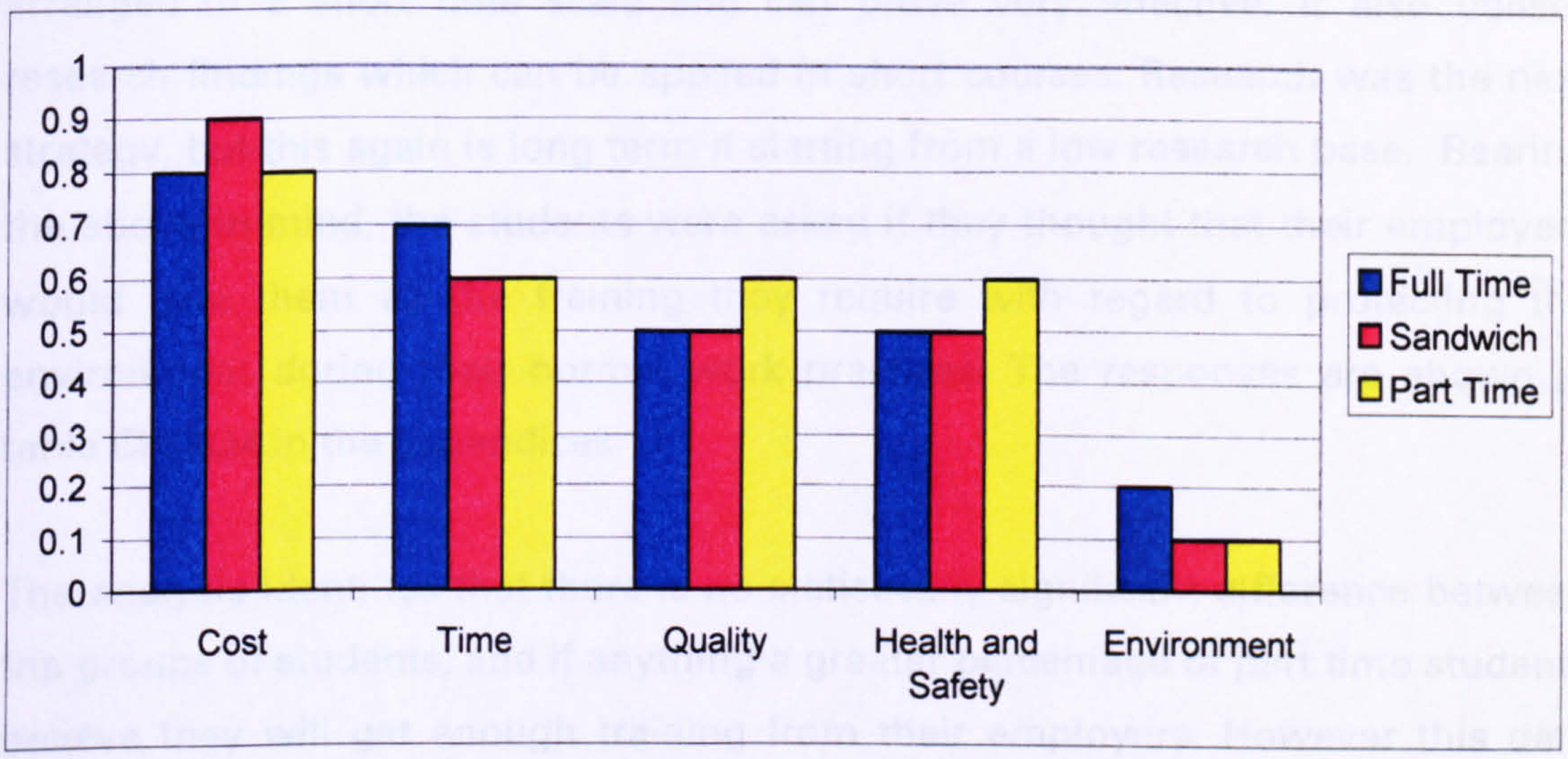


Chart 4.6 Student Perceptions of the factors that industry considers important

Universities role in educating the industry about environmental issues

All but one of the programme leaders agreed that the universities have a role to play in education the construction industry about environmental issues. The one who did not think this was the case argued that universities are not training centres, and industry should organise its own training if relevant to the work required. The respondents who stated yes, recommended the following for actually achieving this:

- Seminars-1 response
- Website development-1 response
- Curriculum-13 responses
- CPD-5 responses
- Consultancy-6 responses
- Industry funded research-4 responses
- Building Regulations- 1 response
- Post Graduate Diplomas-1 response

Ranking the above, the programme leaders appear to believe that the best way of improving the environmental performance of the construction industry is through the curriculum, by changing the way that future professionals in construction view the industry. However this is a long term approach and the second highest level of responses was through consultancy and providing CPD. This can be arranged in a short time scale and can prove very effective. It also utilises research findings which can be applied in short courses. Research was the next strategy, but this again is long term if starting from a low research base. Bearing the above in mind, the students were asked if they thought that their employers would give them all the training they require with regard to protecting the environment during their normal work practices. The responses are shown in table CHISQ4 in the appendices.

The analysis identifies that there is no statistically significant difference between the groups of students, and if anything a greater percentage of part time students believe they will get enough training from their employers. However this data does illustrate that students do not generally believe they will get enough training from their employers, which reiterates the importance of the curriculum and the learning that is achieved in the HE sector.

Question: What influence does industry have on your curriculum, and to what extent?

The responses were as follows:

- We have an have Industrial Liaison Group, and take some of their recommendations on board -6No.
- We have an Industrial Liaison Group, but don't really take their recommendations of board -8No
- Very little influence -6 No.
- No influence at all -2 No.

This illustrates that industry has a very limited influence on the curriculum, if any. Of the institutions who stated that they respond to their Industrial Liaison Group recommendations, none had been advised by industry to include more environmental content. The most common request was to increase the concentration on transferable skills.

Question: Do you think that sustainability/environmental issues will become a more important aspect of the curriculum in the future?

21 of the 22 stated yes categorically, with only one stating maybe. The responsibility for curriculum change was placed by the academics in the following order:

- Academics-13 responses
- Professional Body-10 responses
- Government-6 responses
- Industry-6 responses
- Clients-2 responses
- Students-1 response
- Researchers-1 response

These responses illustrate that academics clearly believe curriculum greening is the role of academia, with the assistance of the professional body who accredit the programme. They were also asked what could fuel these potential changes, and responses were as follows:

- Legislation-17
- Initiatives-10
- Industry requiring it-3
- Professional body, professional research bodies(CIC, CRISP etc.) 3
- Client demands-2
- Student demands-2
- Benchmarking-1
- Academia-1
- Society generally-1

These findings contradict the findings of the literature review which identified that although the majority of environmentalists believe that legislation is the only way to improve environmental behaviour, the environmental education writers believe that initiatives are the way forward linked closely to the curriculum.

Students' personal attitudes

Students were asked a series of questions in order to assess their attitude to environmental issues. The hypothesis was that full time students would have a more ideological and protective approach to the environment than sandwich students, who would in turn have a better attitude than part time students. The questions asked are shown below.

Has your attitude to the environment changed since you started your degree programme?

The results are shown in CHISQ5 in the appendices and demonstrate that there is no statistically significant difference between part time, full time and sandwich students as the null hypothesis is accepted. The majority response was, yes but not very much-49%, with only 24% stating yes, very much.

Do you believe personally that the issue of the environment is important?

The results are shown in CHISQ6 in the appendices and demonstrate that there is no statistically significant difference between part time, full time and sandwich students as the null hypothesis is accepted. The majority response was, yes very much (83%).

When buying your own house, would you pay more if it included environmentally friendly products or systems?

The results are shown in CHISQ7 in the appendices and demonstrate that there is no statistically significant difference between part time, full time and sandwich students as the null hypothesis is accepted. The percentage responses were:
Definitely-12%
Probably-35%
Maybe-35%
No-18%

These figures do not support the responses from the previous question because 83% of students state that they believe environmental issues are very important, and yet only 12% would definitely pay extra for an environmentally friendly property. This would indicate that although students believe ideologically they should care about protecting the environment, when there is an increased cost involved, cost takes precedence.

Do you believe that technology alone can solve the environmental problems the world faces?

The results are shown in CHISQ8 in the appendices and demonstrate that there is no statistically significant difference between part time, full time and sandwich students as the null hypothesis is accepted. The majority response was "No" (73%) indicating that the students have an appreciation that attitudes and education are also important.

Do you think the construction industry poses a major threat to the environment?

The results are shown in CHISQ9 in the appendices and demonstrate that there is no statistically significant difference between part time, full time and sandwich students as the null hypothesis is accepted. The majority response was 'Definitely' (45%) indicating that some students have sufficient knowledge of the damaging impact of construction work on the environment. However 55% do not and these students were very close to completing their studies.

Chart 4.7 summarises the findings of the whole sample with regard to environmental attitude

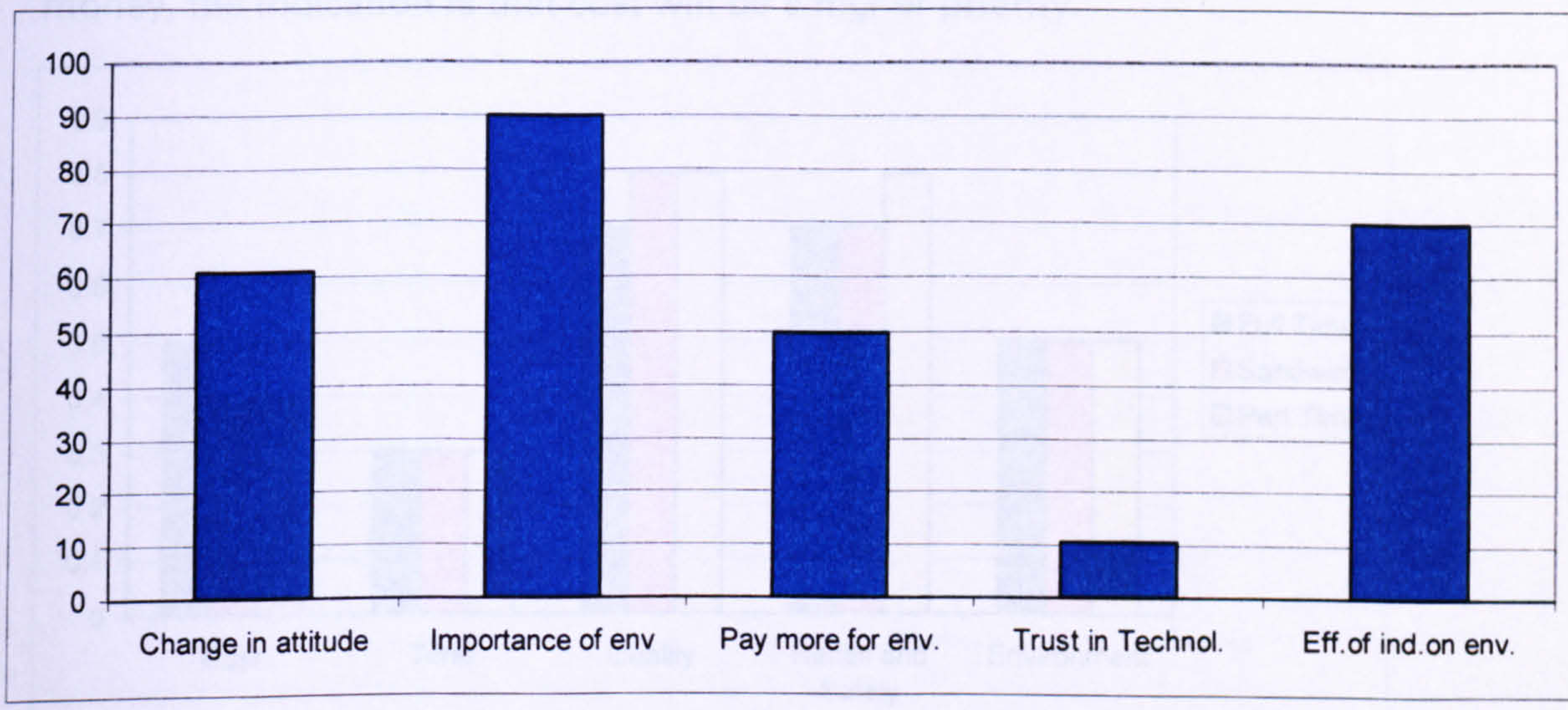


Chart 4.7 Whole sample response summary of environmental attitudes

60% stated that their attitude to the environment had improved since they had started the programme, 90% stated they believed the issue of the environment is important, 70% believed that the construction industry poses a major threat to the environment and only 10% believed that technology alone could solve the environmental problems the world faces. These figures show an awareness and understanding of the environmental impact of the built environment, plus an improvement in attitude developed through education, and contradicts the findings of the literature review that students studying technical subjects have blind faith in technology.

However only 18% stated they would definitely, personally pay more to protect the environment, which illustrates that environmental attitude may not be strictly linked to environmental behaviour.

Factors that students believe are important in the construction process

As illustrated in chart 4.8 All three groups rate time as the least important, quality and health and safety as the two most equally important issues which does bode well for the industry generally, as many would consider these to be the most important factors. They also rate environmental issues higher than cost, which is also a good indication of how importantly the student body rates preserving the environment. However when asked if they would spend more of their personal money, the indication is that cost will be a higher priority.

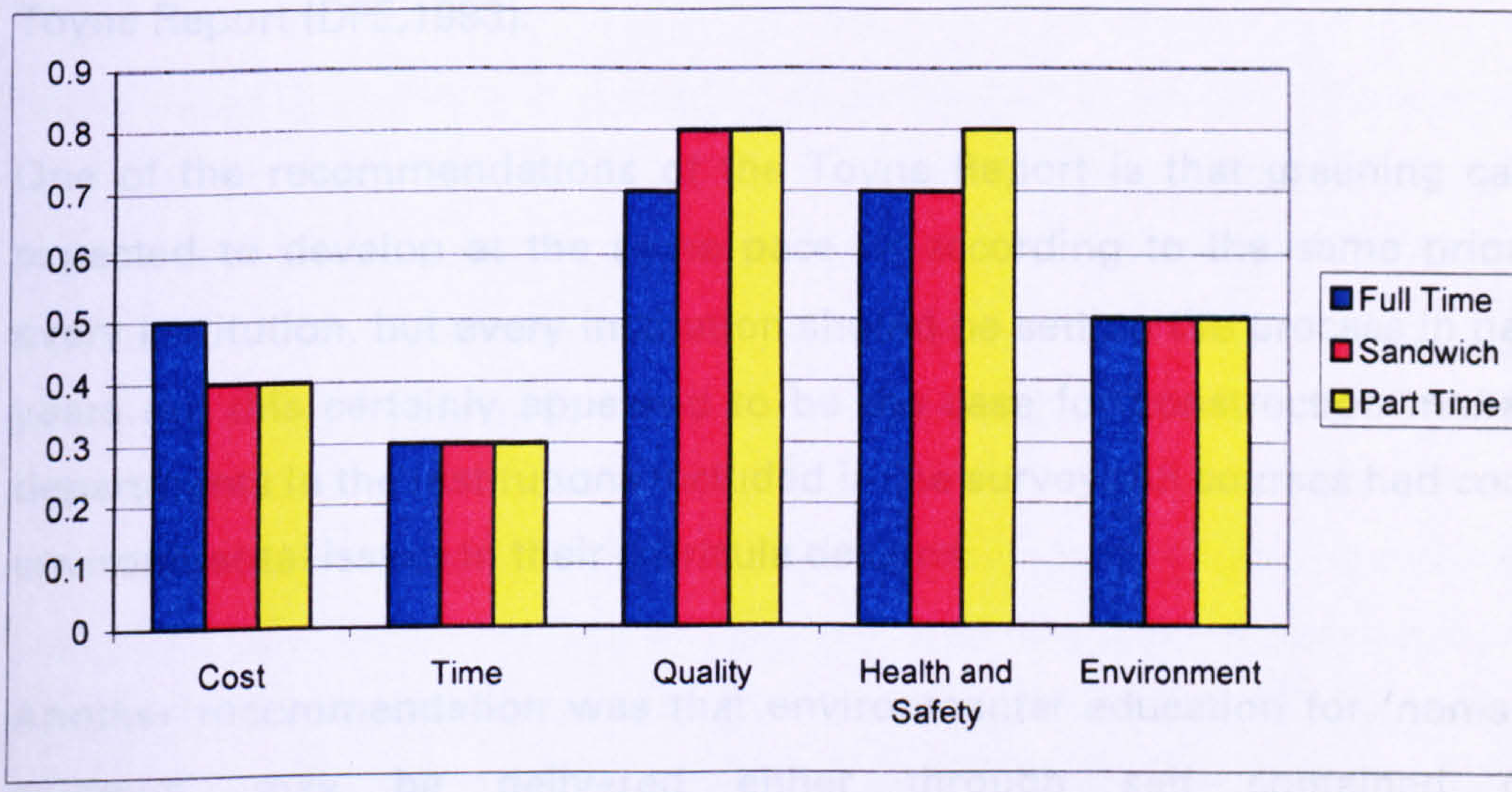


Chart 4.8 Factors that students perceive as important in the construction process

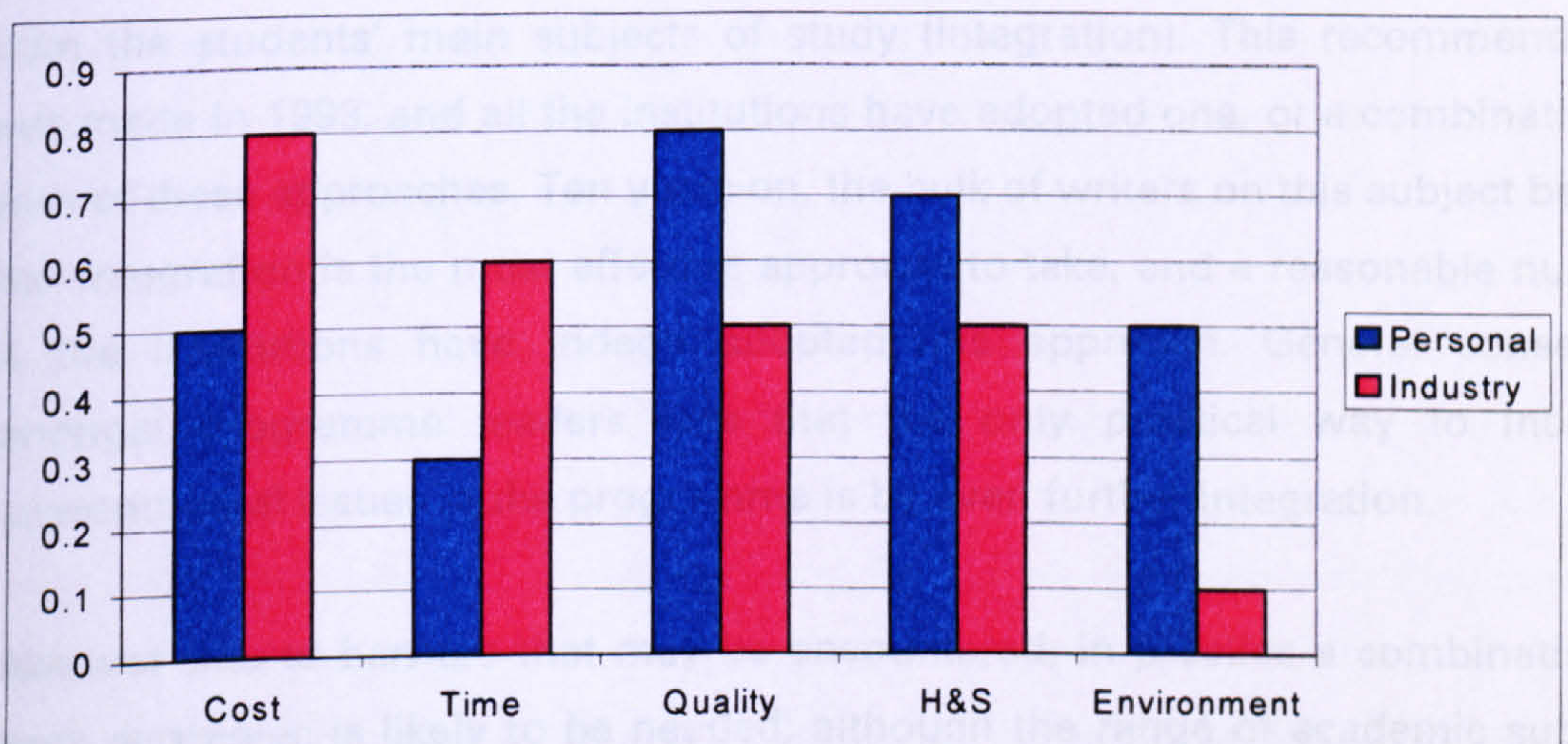


Chart 4.9 Comparison of students personal ratings of factors of importance compared to those they perceive the industry to hold important

A reassuring comparison is given in chart 4.9, which indicates that students personal factors of importance are different from the factors of importance that they perceive the construction industry to have. If these attitudes continue after graduation and into employment in the industry then changes may come about. However, students may be heavily influence by current industry practices, although the results for part time students do not strongly support this scepticism.

4.3.4 Assessment of progress made in addressing the recommendations of the Toyne Report (DFE,1993).

One of the recommendations of the Toyne Report is that greening cannot be expected to develop at the same pace or according to the same priorities, in every institution, but every institution should be setting the process in hand. Ten years on, this certainly appeared to be the case for construction management departments in the institutions included in the survey. All courses had considered environmental issues in their curricula designs.

Another recommendation was that environmental education for 'non-specialist students' may be delivered either through self contained modules (fragmentation), or by developing environmental themes which naturally arise from the students' main subjects of study (integration). This recommendation was made in 1993, and all the institutions have adopted one, or a combination of both of these approaches. Ten years on, the bulk of writers on this subject believe that integration is the most effective approach to take, and a reasonable number of the institutions have indeed adopted this approach. General consensus amongst programme leaders was that the only practical way to increase environmental issues in the programme is by even further integration.

However due to barriers that may be encountered, in practice a combination of these strategies is likely to be needed, although the range of academic subjects providing scope for the integration of environmental issues is much wider than was envisaged in the Toyne Report.

The role of professional bodies that accredit HE programmes was identified in the report. All professional institutions should seriously assess, or, as the case may be, reassess, the place of environmental issues within those HE courses for which they control or influence the curricula, and take action to promote the appropriate changes. The CIOB 1994 and subsequently the 2002 educational frameworks did indeed address this issue, but as has been evidenced by the feedback from the HEIs, interpretation of the framework can be flexible, and relies on the opinions of the visiting accrediting panels as to whether this particular aim is addressed in totality. The argument against full compliance is that the framework is very detailed and includes a great number of subjects which can be difficult to 'fit' into a modular degree programme.

Some elements need to be omitted and in some cases this appears to be the environmental content. The 2002 framework emphasises the need to include environmental issues to a greater extent, but the framework is still very extensive. The programme leaders have accepted this when identifying that the way to include more environmental content is integration.

The Toyne Report highlights the fact that the results of improved environmental education will take a long time to influence environmental behaviour to any great extent. To this end it recommended that FHE's response to the needs of the workforce will need to include specialist qualifying courses, 'updating' for those who are already in the workforce and the provision of environmental education for the student body at large. Again this point was reiterated by programme leaders who realise the role and responsibility that universities have in providing these forms of training and education.

It would appear then that the Toyne Report (DFE, 1993) recommendation have been taken on board by construction management departments, whether other departments have as well is out of the scope of this study. However there are indications that this may not be the case. One of the recommendations was that each institution's policy for environmental education should include, in particular, a strategy for the promotion of environmental education across the curriculum, together with an action plan for it's implementation. Of the twenty-two institutions contacted, only three stated that this was the case in their organisation. A further eight stated that their organisation had an environmental strategy but it did not include for curriculum design. Eleven respondents stated either no or don't know which was half of the total sample. This would indicate that only a minority of institutions have taken the recommendation seriously, some have tried developing the idea of green campuses, and 50% have not addressed these issues at all.

The report commented that, to date, much of the progress made with greening has reflected departmental initiatives rather than institutional strategies. This would appear to still be the case ten years on.

The overriding recommendation of the report was each FHE institution, pursuant to its overall environmental policy should adopt a strategy for the promotion of environmental education across the curriculum, together with an action plan for its implementation. From the evidence collected to date, this has not occurred in the majority of HE institutions offering construction management courses.

4.3.5 Summary of conclusions from analysis of educational data

The primary data collected has enabled some useful conclusions to be formed. The level of awareness of environmental issues related to the construction industry appears to be relatively constant amongst students both geographically and by mode of study, and does not depend on a programme having a specific environmentally focussed programme aim. Students appear to believe there is more emphasis in this area within their programme than programme leaders, indicating that there is far more integration of environmental issues than the programme leaders believe. Interestingly, for example, the programme leaders stated that sustainability as a subject was mainly included in technology modules, but student knowledge was better in more management related topics highlighting that module leaders of management subjects are discussing environmental issues within their subject.

Interdisciplinary education is being utilised by universities but only a minority stated that it had been encouraged for educational reasons, more stated that cross school teaching was being adopted for resource efficiency reasons. However this was contradicted by the majority of programme leaders belief that the most effective method of assessment for environmentally focussed elements of the curriculum was group based interdisciplinary projects, which in itself was contradicted by the student response that the assessment and group working elements of their programme had less of an environmental focus than the modules and lectures.

There were no statistically different differences in knowledge and attitude between students who studied at the high rated research institutions as opposed to those studying at a low rated institution. This was surprising given that the levels and amount of research vary considerably across the sector with very high standard deviations and coefficients of variability. It was expected that the students studying at universities at the higher end of the scale would give very different responses, the figures indicate that research rating in this area has little impact on student learning.

The responses from the students indicate that learning has improved attitude, but not necessarily behaviour to the same extent. Changing behaviour of students in industry after graduation is out of the scope of this study, but as there has been much research undertaken proving that student learning to improve attitudes is linked to improved environmental behaviour, the importance of student learning is evident. This is obviously taking place at the institutions involved in the scoping study. There are very little statistically different response rates between full time and part time/sandwich students. It was expected that there would be differences given the negative views the student body appears to have about the way the construction industry addresses the environmental agenda. Part time students especially can be more closed to different ideas as to how the industry performs or should perform, but this does not appear to be the case in the sample, and again illustrates the importance of education in encouraging environmental literacy.

However, although not statistically significant, part time and sandwich students do generally believe that the industry does not do enough to protect the environment. Full time students do appear to have a more ideological impression of the industry.

Programme leaders do not generally believe that industry has a great deal of input into the design of the curriculum, and they stated that industrial liaison panels do not encourage more inclusion of environmental issues. The main recommendation from industry appears to be that they require more development of transferable/key skills in the students. Although this is not the focus of the research being undertaken, any curriculum redesign will need to include for this recommendation if the programme is to achieve the aims of currency and relevance to industry requirements.

Generally the programme leaders believed that the CIOB 1994 educational framework is too restricting, and that the 2002 framework is not radically different. However the findings have contradicted this understanding to a certain extent and have indicated that the framework is very much open to interpretation. The framework clearly states that environmental issues should be integrated into the programme, but most programmes deliver these subjects in a fragmented or partially integrated way. The JMU curriculum certainly falls into this category and has achieved full accreditation twice using the 1994 model. Flexibility is actually a key factor in the framework because different institutions have very different staff expertise and this is allowed to feed into the curriculum and flavour the particular course. The flexibility is built in through the accreditation process and if the institution can argue that their programme satisfies all CIOB requirements, whilst still allowing their specialisms to develop and feed into the curriculum, then it will be accredited. However even though the institutions where there are more staff interested in this area have made more developments, all institutions stated they would be keen to develop more in this field.

All of the programmes in the sample have a curriculum model that is more comparable with the CIOB 2002 educational framework, which promotes the studying of all subjects in all three levels, and changing the performance indicators for each level. This is because this model is a more traditional model where subject strands start in the first level and increase in complexity until the final level.

Academic staff favour integration as the way of developing the environmental content of their programmes, because there is a danger of the programme changing from one of construction management, to one of environmental management. Construction management students need to have a knowledge and understanding of a wide range of subjects, plus some subject specific skills. If they do not have these because the programme has been changed too much, then they will not have the necessary background for them to be useful to industry upon initial employment. Integration is therefore seen as the way to promote environmental issues and also of relating everyday construction practices to potential environmental problems and hence solutions. A number of programme leaders did however state that they would only change the curriculum if forced to do so by the CIOB, with the most likely time for making major changes being before an expected reaccredidation visit. As these take place every five years this could have a wide reaching effect on industry, and the students it employs. This contradicted with the opinions that the programme leaders had about responsibility for curriculum design. The majority response was that it was academics that should take the lead in this area, and that they should be teaching students what is best practice so that students will change the way the industry performs over the coming years.

The barriers that prevent more development in this area link closely to the findings of the literature review, but the most commonly stated barrier was that of staff time and willingness to develop material in this area. Due to the falling numbers of construction management applicants, there have been staff reductions to compensate. This leads to less staff with more roles to undertake.

If student numbers fall from 30 to 15 in a cohort, the number of staff contact hours, pastoral and administrative duties remain the same, the only element of the academic's role that reduces is the marking of student work. Programme leaders stated that staff workloads are increasing year by year and this increases the problem of lack of time to develop new material. Staff would be willing to improve their expertise if given the time to do so, however in academia today this situation is likely to worsen rather than improve. This does not bode well for any change of direction in curriculum design.

More positively, the programme leaders concur with the author that the best way to improve the environmental performance of the construction industry, is through the curriculum of higher education programmes. Even though this is a long-term solution and there are more short-term solutions that could be employed, the validity of the research being undertaken is confirmed.

Environmental issues related to construction appear to be popular with students, evidenced by the number who are undertaking a dissertation with an environmental focus, and also by the student responses as to why they believed the industry does not do enough to protect the environment and the relevance of their future career to the environment. These responses indicated that the student body has a good understanding generally of the impact of construction on the environment and how their own performance could enhance the industry performance. Very positively students rated quality and health and safety as the two most important factors in the construction process, with environmental performance ranking the same as cost.

The main recommendations gleaned from these results for curriculum design are therefore as follows: -

- A specific environmental programme learning outcome is useful, but not essential for ensuring that environmental literacy is developed in students.
- Multidisciplinary teaching is becoming more prevalent mainly due to resource issues, but it is also very important for encouraging closer working of professionals in the industry.
- Group working and multi disciplinary projects are the best form of assessment for developing environmental understanding of the impact of construction
- The development of transferable/key skills needs to be an essential part of any curriculum redesign.
- Environmental issues should be integrated as much as is possible as recommended by the CIOB educational framework, however partial fragmentation is also effective if combined with integration in the majority of modules.
- The CIOB framework should be adhered to as much as possible, the 2002 model is far better from an educational perspective than the 1994 model.
- The main barrier to greening of the curriculum will be the reluctance by staff to develop their subject area to integrate environmental issues due to time constraints.

As has already been stated, the findings made in the educational data collection and analysis part of phase 1 are interesting and useful. However there are many aspects that contradict the literature review and current academic thinking, especially the finding that student knowledge and learning at low rated research institutions are not significantly different to those studying in high rated research institutions. There are also aspects that need further clarification. The findings of this part of the data collection and subsequent analysis have been utilised to develop an additional methodology and methodological design to further develop potential curriculum design interventions that could improve student environmental literacy.

4.3.6 Industry Data Analysis

All of the respondents worked for Local Authorities in England and Wales, and therefore the organisations they work for are very similar. At the time that the questionnaire was sent out, 97% of Local Authorities claimed to have Local Agenda 21 policies and it was envisaged that this would have some impact on the working practices of building works departments.

The questions were designed to assess whether the respondents were aware of their Local Authorities Local Agenda 21 policy, if they were whether it is actually implemented, their thought on the willingness of their employers to pay for improved environmental performance in construction works, their understanding of sustainable construction and identification of the role that they believe universities can have in the education of Local Authority employees.

The data collected is quite basic, as this is not the main focus of the research project, it is simply being used to validate the need for the project. As there is a lack of variables between the respondents, undertaking a statistical test of the data is not valid. The data is presented using descriptive statistics only.

Profession of the respondent

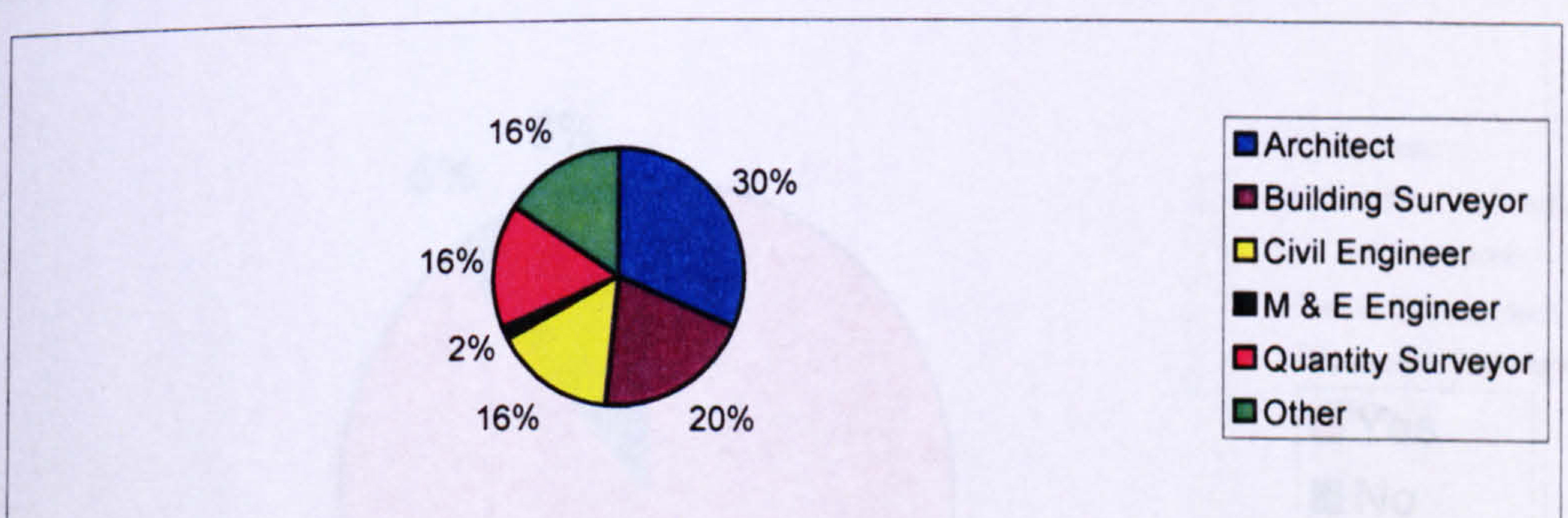


Chart 4.10 Profession of respondent

The 'other' respondents included conservation officers, environmental officers, a LA21 support manager, the head of construction services and several planners. 68% of the respondents are involved in the design phase of construction work, and none in the construction production management phase. The sample is therefore deemed representative designers, who also act as clients.

The respondents were asked if they understood what local agenda 21(LA21) aims to achieve. The response rates are given in chart 4.11 and are very positive. They were also asked if their local authority had an LA21 and again very positive responses were given as shown in chart 4.11.

Understanding of Agenda 21

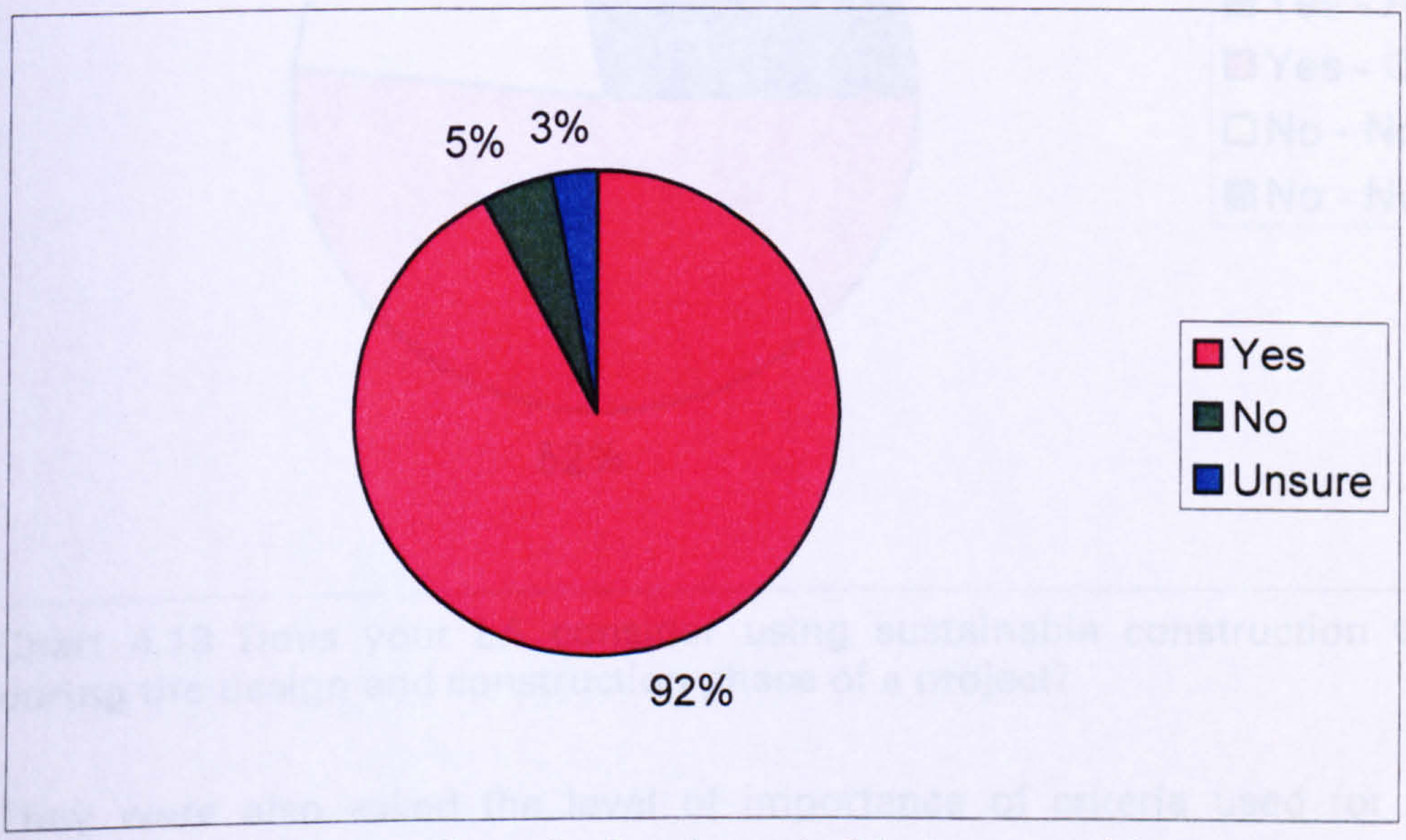


Chart 4.11 Understanding of what Agenda 21 aims to achieve

Local Authority adoption of Local Agenda 21

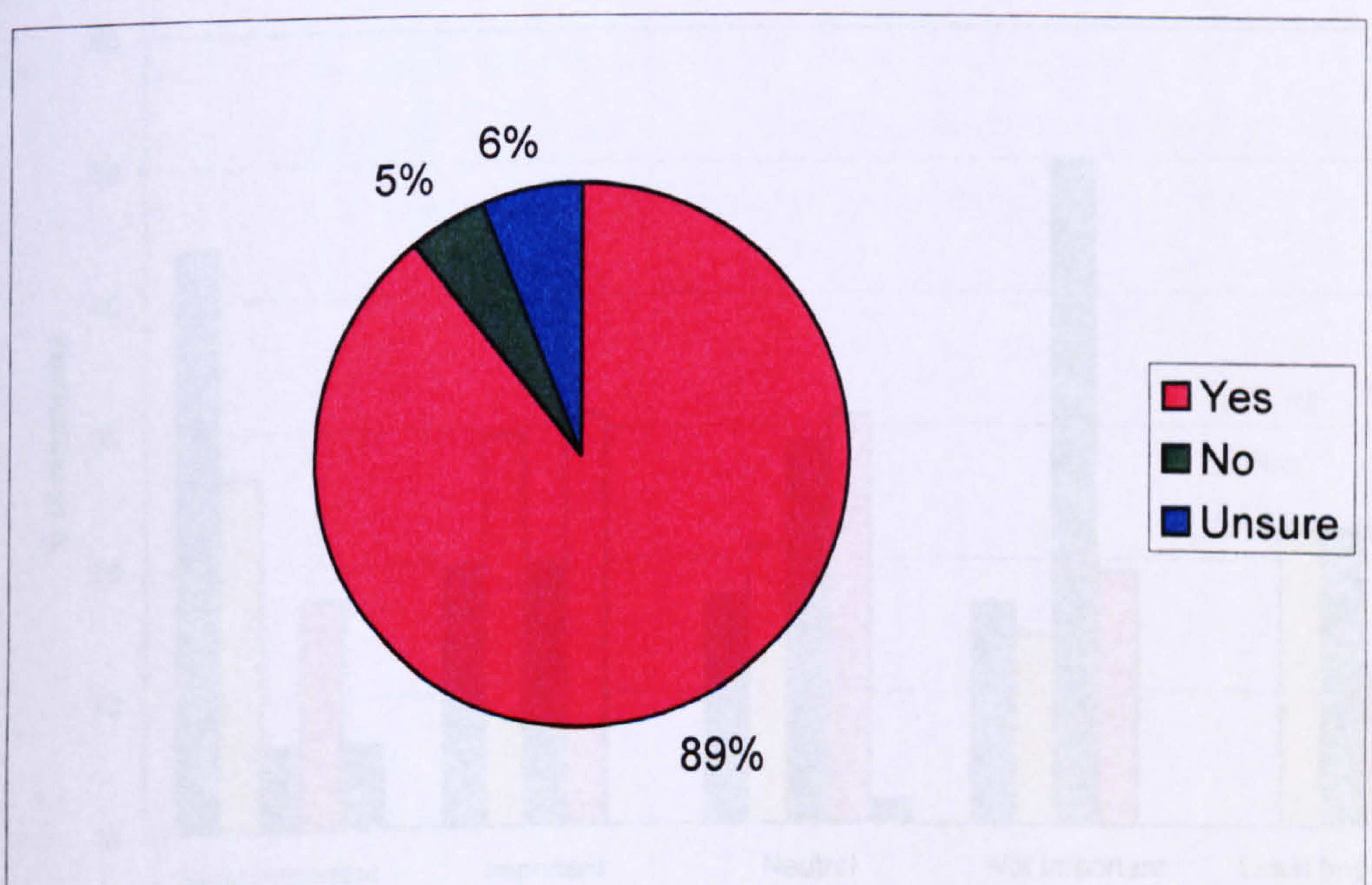


Chart 4.12 LA21 policy adoption

The respondents were asked if their local authority utilised sustainable construction techniques and the summary of responses is given in chart 4.13

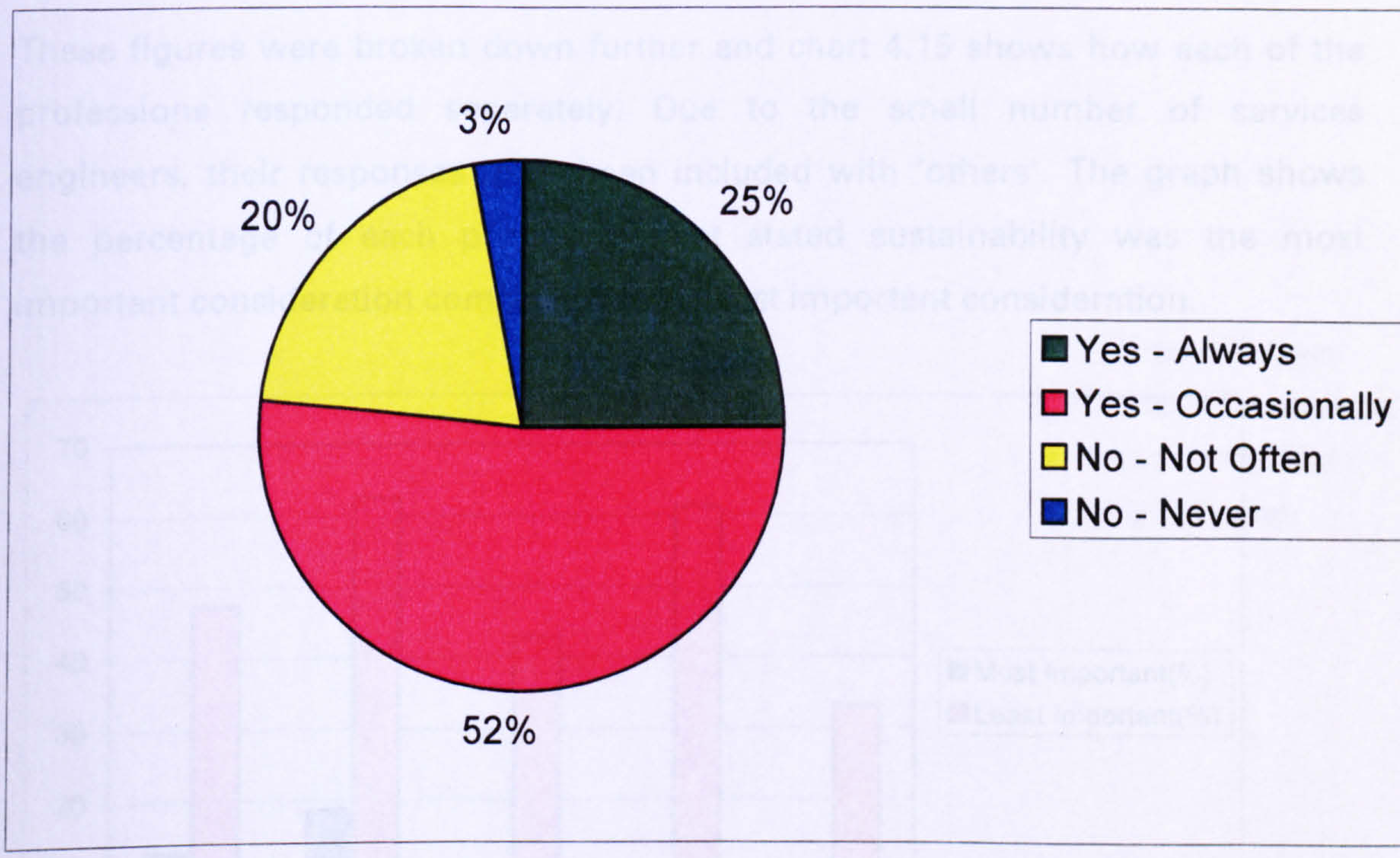


Chart 4.13 Does your LA consider using sustainable construction techniques during the design and construction phase of a project?

They were also asked the level of importance of criteria used for specifying building materials in the design stage by their local authority.

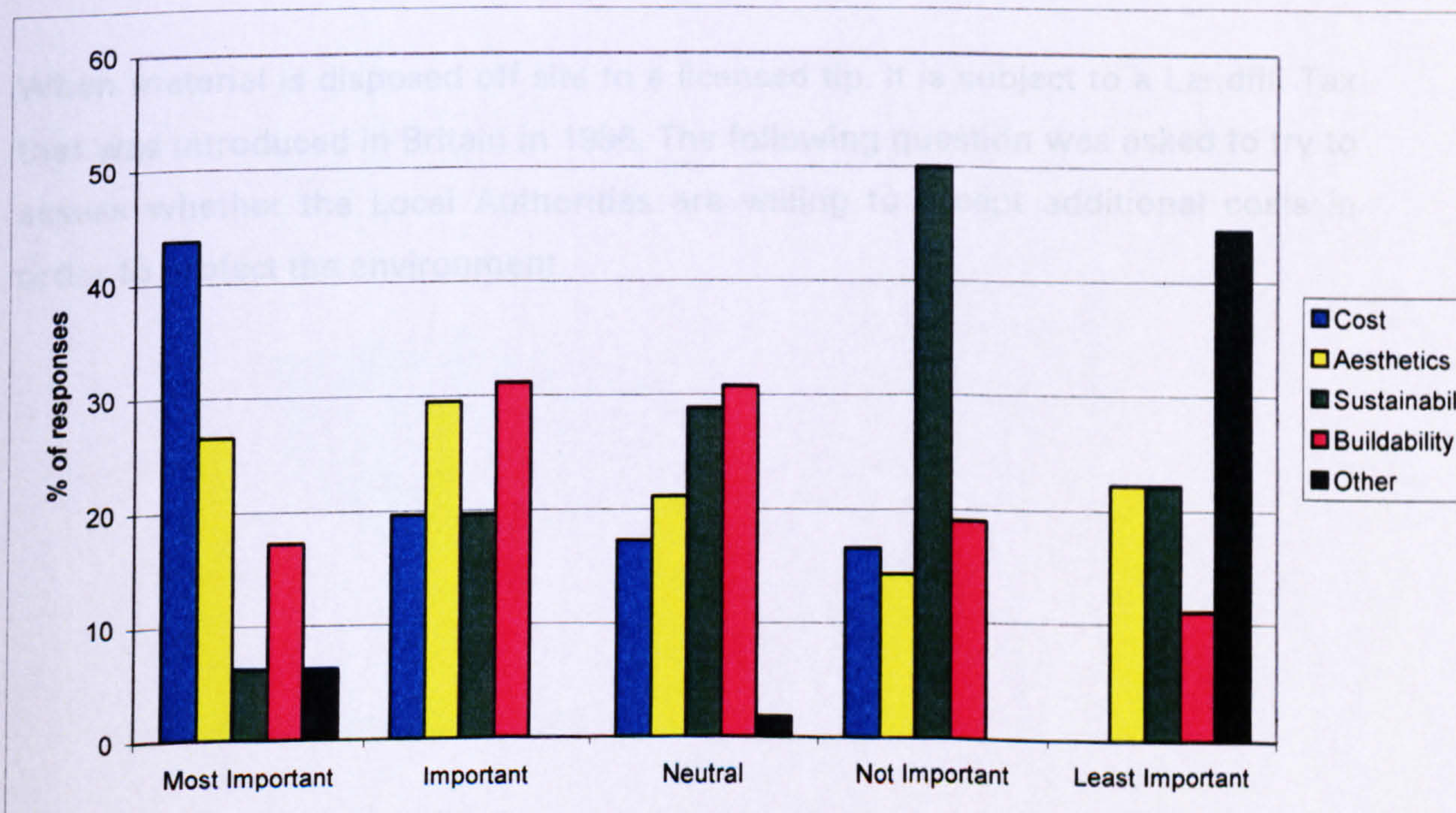


Chart 4.14 Factors of importance when specifying a building material

The 'other' group contained health and safety and ease and cost of maintenance.

These figures were broken down further and chart 4.15 shows how each of the professions responded separately. Due to the small number of services engineers, their responses have been included with 'others'. The graph shows the percentage of each profession that stated sustainability was the most important consideration compared to the least important consideration.

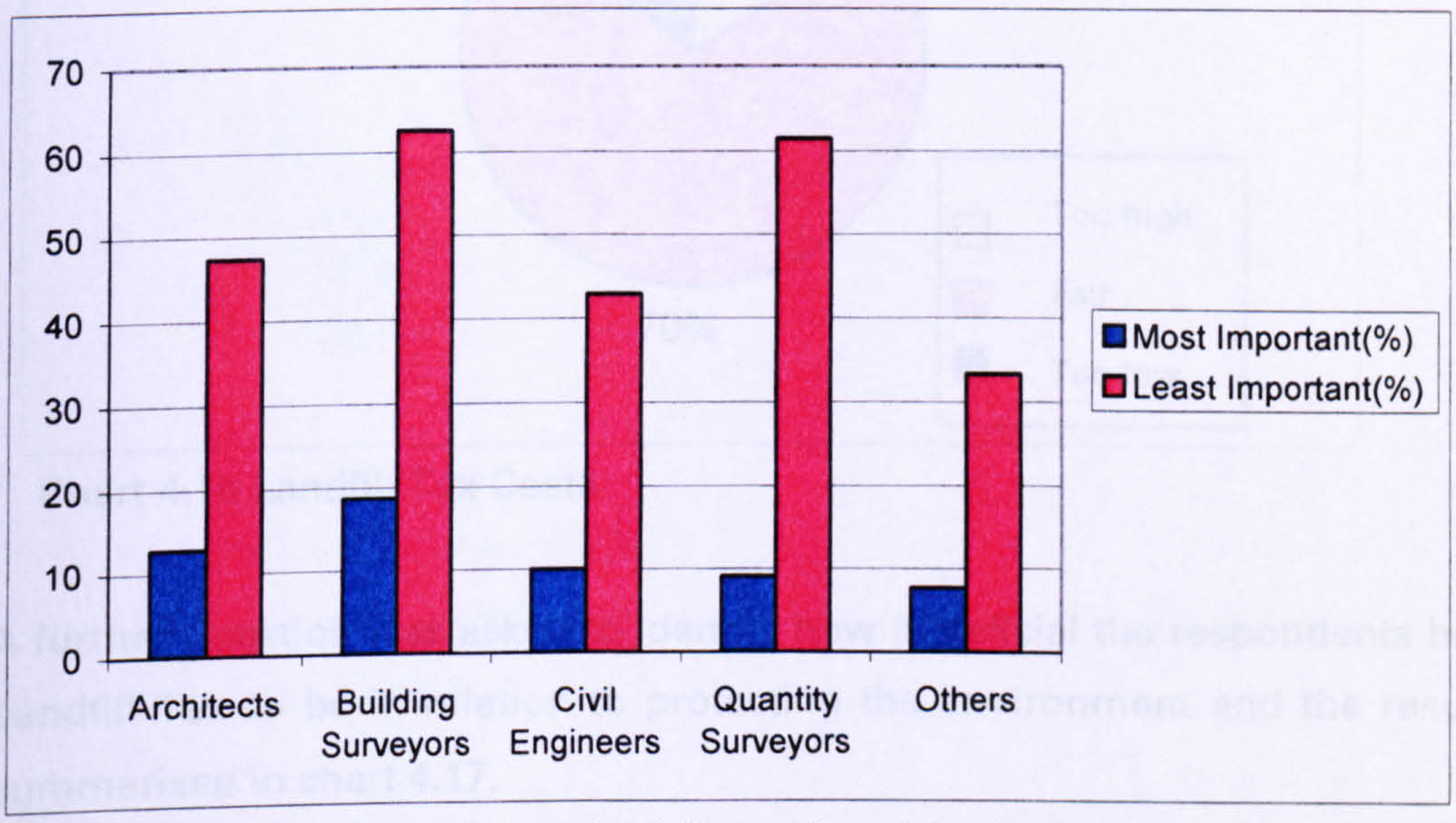


Chart 4.15 Importance of sustainability to Local Authority Respondents

When material is disposed off site to a licensed tip, it is subject to a Landfill Tax that was introduced in Britain in 1996. The following question was asked to try to assess whether the Local Authorities are willing to accept additional costs in order to protect the environment.

What do you think about the cost of the landfill tax?

The response rates are summarised in chart 4.16

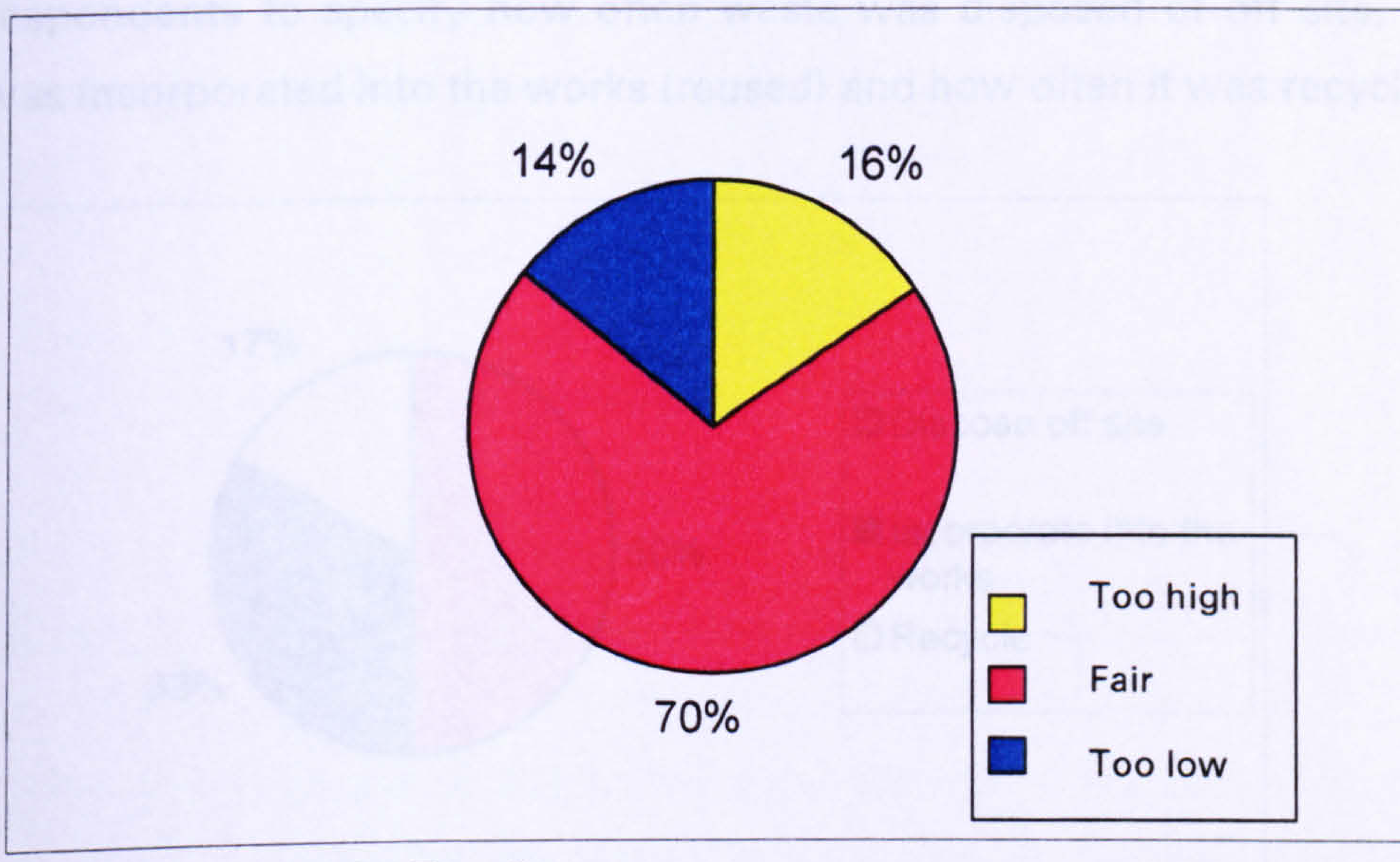


Chart 4.16 Landfill Tax Costs

A further question was asked to identify how beneficial the respondents believed Landfill Tax to be in relation to protecting the environment and the results are summarised in chart 4.17.

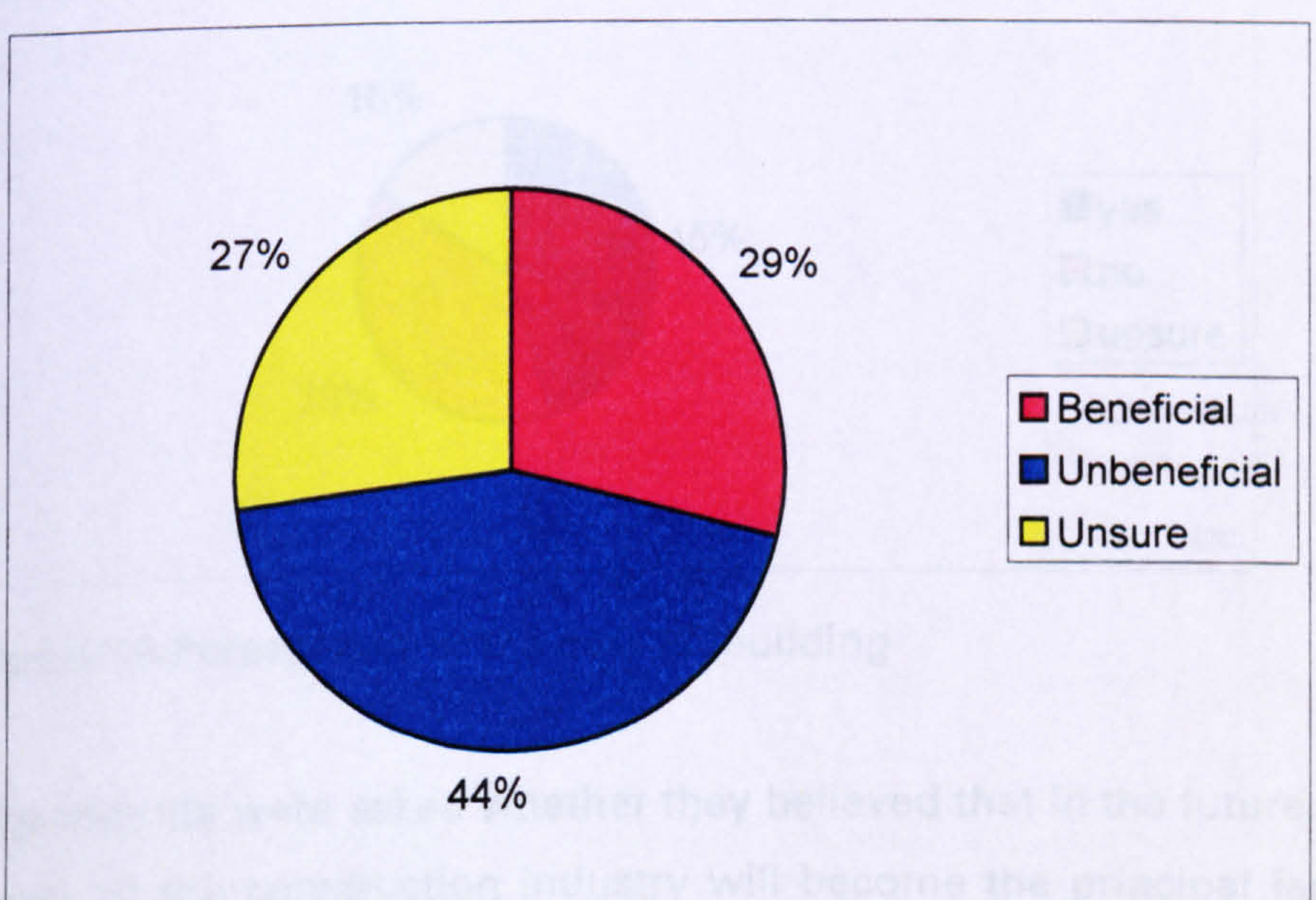


Chart 4.17 Benefits of the landfill tax

Construction waste disposal policies

The recycling and reuse of waste is one of the main principles required if construction is to be classified as sustainable. The next question asked the respondents to specify how often waste was disposed of off site, how often it was incorporated into the works (reused) and how often it was recycled.

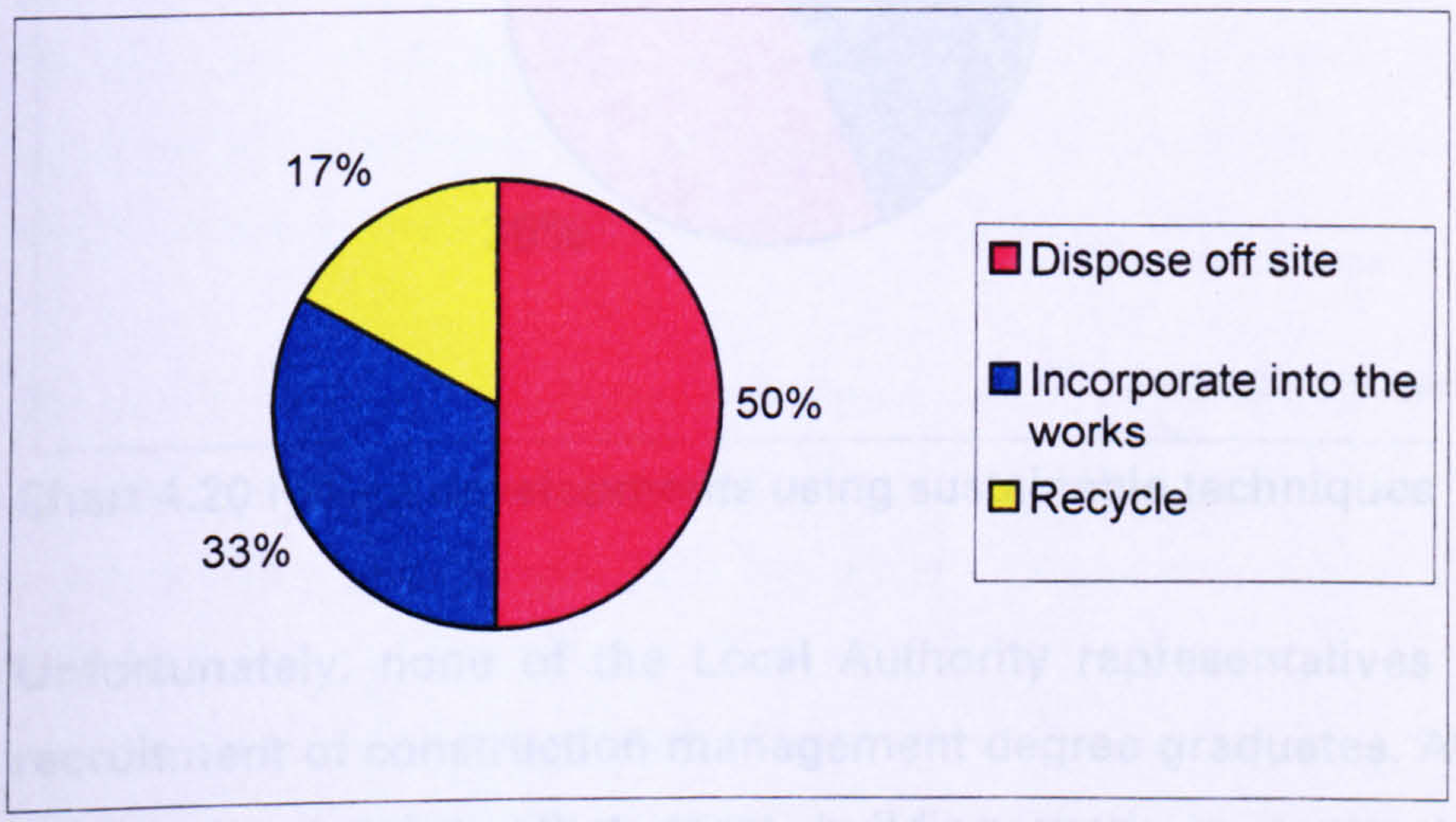


Chart 4.18 Waste disposal policies

The respondents were asked if the understood the cost implications of sustainable construction

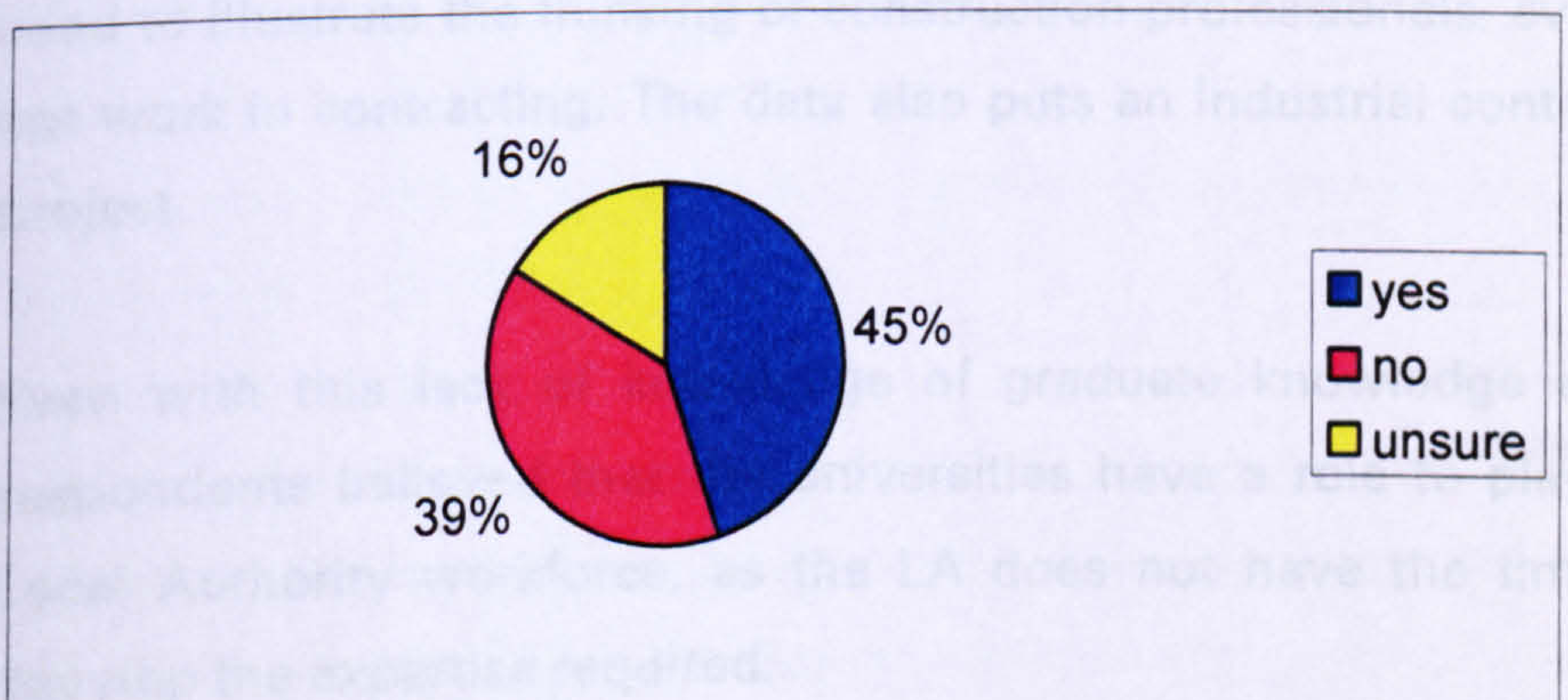


Chart 4.19 Perceptions of the cost of 'building

Respondents were asked whether they believed that in the future, the sustainable aspect of the construction industry will become the principal factor to consider ahead of costs and aesthetics. Interestingly, the profession that least believed this to be an issue was the architects. Only 25% believed it could become the principal factor, whereas 45% believe that it will not.

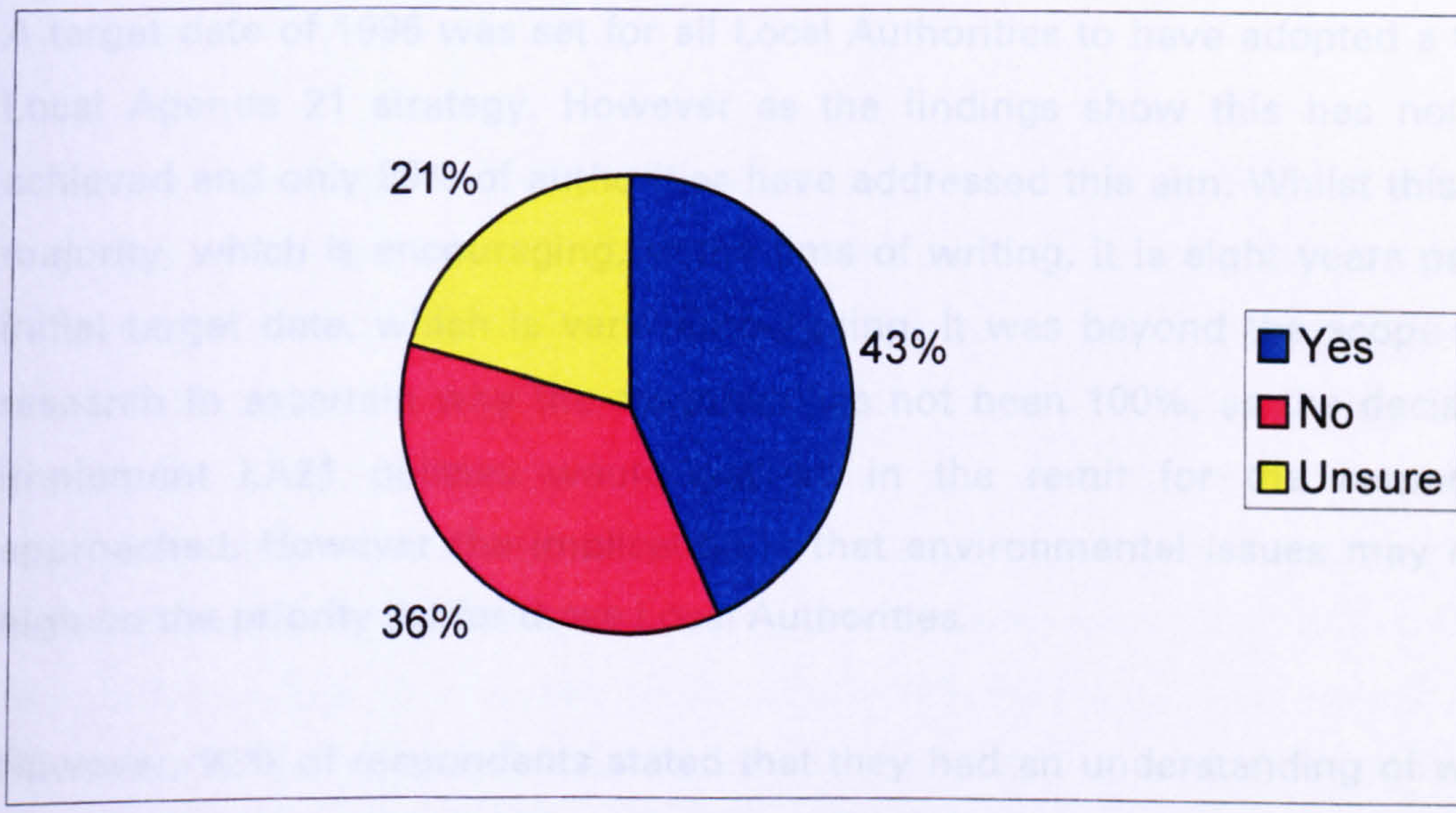


Chart 4.20 Future developments using sustainable techniques

Unfortunately, none of the Local Authority representatives was aware of any recruitment of construction management degree graduates. Although this was to be expected, given that most building work is contracted out to private contractors, it means that questions relating to the competency of graduates are irrelevant. Therefore correlations between these responses, and the educational data generated are impossible. However the data is still valuable as it can be used to illustrate the thinking of construction professionals, even though they do not work in contracting. The data also puts an industrial context to the research project.

Even with this lack of knowledge of graduate knowledge and skills, 87% of respondents believed that the universities have a role to play in educating the Local Authority workforce, as the LA does not have the time or resources to develop the expertise required.

4.3.7 Summary of conclusions from the analysis of industry generated data

The survey was designed to assess whether Local Authorities have a Local Agenda 21 policy, if they do, is it implemented in construction, willingness to pay for improved environmental performance in construction works, the understanding of sustainable construction and finally identify the role that universities can have in the education of Local Authority employees.

A target date of 1996 was set for all Local Authorities to have adopted a formal Local Agenda 21 strategy. However as the findings show this has not been achieved and only 89% of authorities have addressed this aim. Whilst this is the majority, which is encouraging, at the time of writing, it is eight years past the initial target date, which is very discouraging. It was beyond the scope of the research to ascertain why the response has not been 100%, as the decision to implement LA21 policies would not be in the remit for the respondents approached. However the implication is that environmental issues may not be high on the priority list for those Local Authorities.

However, 92% of respondents stated that they had an understanding of what is meant by LA21, which indicates that even if the Local Authority does not have a formal policy, staff have become aware of the principles of LA21 themselves. Bearing the above in mind, it is surprising that only 25% of Local Authorities always consider using sustainable construction techniques, with 23% stating that they only consider using them occasionally or never. This indicates that even though the Local Authority has a LA21 policy, it doesn't filter into construction work practices. No identification of the Local Authorities was asked for, and in hindsight this would have been useful. However it can be assumed that the Local Authorities that are most proactive in promoting the use of sustainable construction techniques will be the ones that are rural and rely on the maintenance and/or improvement of the environment to retain and improve income generation through tourism.

It was assumed from the findings of the literature review that clients (Local Authorities) whose construction work is funded from public sources would identify sustainable construction as a highly important criterion, as opposed to the private sector that would identify cost as the most important. However the findings of the survey contradict this assumption as 45% of Local Authority respondents stated that cost was the most important criteria, and only 6% who stated that sustainability was the most important. Perhaps more importantly 50% stated that sustainability was not important. By profession the greatest different in the percentage who stated that sustainability was the most important compared to the least important was the quantity surveying group (9% compared to 62%), and as they are mainly concerned with costs this was a likely outcome.

However the professions involved with the design of buildings also indicated big differences.

From this information it can be assumed that public accountability of funding is still high on the priority list for local Authorities, which is understandable and indicates that if the general population were more vociferous in wishing to protect the environment, then this would filter into Local Authority practices. If the cost of every scheme was justified from an environmental perspective then it relies on the council taxpayer to want this requirement. One interesting outcome is that Local Authorities appear to equate sustainable construction with increased cost, and this links to lack of understanding of what sustainable construction is. If the definition of sustainable construction identified in chapter 2 is referred to, most of the principles required to achieve sustainable construction do not cost more, and in fact some can even reduce costs, such as reuse and recycling.

Another contradictory set of data relates to the Landfill Tax. The majority of respondents (84%) stated that they believed that the Landfill Tax was fair or even too low, BUT only 29% believed that it's introduction will help to protect the environment by promoting recycling and reuse. Consequently 50% of respondents stated that tipping off site was still the most common option taken with regard to waste disposal, and only 17% stated that they have a policy to recycle all waste. A further question that needed to be asked given the findings of the survey would be to identify if Landfill Tax charges were to increase further, would the Local Authorities review their disposal policies.

Less than half of the respondents believe that environmental issues and the use of sustainable construction techniques will become more important in the future, again this is surprising especially with revisions to part L of the Building Regulations, which could have far reaching implications for Local Authorities.
The overall conclusions gained from the data generated are:

a. The majority of respondents stated that they have a thorough understanding of Agenda 21 and it's implications. The later questions identify that this is not the case as the benefits of the Landfill Tax are not appreciated and all pointers, including the changes to the Building Regulations would imply that environmental performance of construction in all sectors will have to improve in the future. Also the assumption that 'building green' will cost more identifies a lack of understanding of what sustainable construction actually is.

b. The majority of the respondents stated that their Local Authority has a LA21 policy. However it clear that although the respondents know the policy is in existence, the ethos of these policies is not filtering into practices in the building works departments.

It has been stated in the literature review that Local Authorities should take the lead in promoting the use of sustainable construction methods for all construction works, and by taking the lead become an example to the construction industry generally. However the results of these findings would suggest that this is not the case at this time. Local Authorities may need to review their LA21 policies and ensure that they clearly state the priority that sustainable construction should have in the list of criteria for building work. The respondents are mainly designers and it is they who can have a dramatic effect on the use of more sustainable methods. However, developing a policy is only the first step. The policy has to be communicated to all staff in a way that is understandable. It is evident that there is a lack of knowledge of how building work can be more sustainable, with little increase in actual costs. This suggests that education and training are of paramount importance and should perhaps be put high on the agenda for the Local Authorities. Universities could deliver the expertise required, and as the survey suggest, the majority of respondents believe this would be desirable.

4.4 Conclusions of Phase 1

The conclusions attained from the industrial data analysis, validate the need for this research. This is because it is evident that industry practices and knowledge of environmental issues related to construction and property are not developed enough to make the differences required to prevent further environmental damage. In addition 43% of the industrial respondents stated that in the future they believe there will be more pressure on them to act more environmentally responsibly.

These findings are corroborated by a 2003 survey on the sustainability performance of the UK construction industry carried out by Sponge, an online network of construction professionals with an interest in sustainable development. The Sponge survey identified affordability as one of the key barriers to sustainable construction (Sponge (2004)). Sponge also identified that one of the key barriers to developing a more 'sustainable' industry was a lack of understanding of key issues and many of its respondents stated that sustainability should be a:

'cornerstone in education for construction'

and that academic institutions need to improve their sustainability coverage The conclusions formed after the analysis of the educational data are inconclusive in some areas, and need further clarification in others.

Phase 2 of the research project aims to provide further clarification and complete sufficient work to allow for a model of curriculum design to be developed.

5.0 Phase 2- Supplementary UK Data Collection and International Perspective

5.1 Introduction

The initial research undertaken in phase 1 illustrated that what programme leaders say they do as far as the curriculum is concerned, appears to be different from the perceptions of the students. The students believed there was more environmental content in their programme than the programme leaders. Hence further investigation was required as to why this was the case. It has also been identified that the environmental literacy that the HE sector is developing in students is at a higher level than is required by industry at the moment, but potentially not in the future. Therefore the issues relating to the inclusion of environmental issues into the curriculum needed to be further investigated if concepts relating to curriculum design are to be developed. In addition more clarification as to who the stakeholders should be with regard to curriculum greening and the level at which professional bodies should intervene needed to be investigated further.

The aim of the research project is to develop concepts relating to curriculum design based on the systematic collection and subsequent analysis of data. This approach forms the basis for the development of grounded theory, and therefore the data collection needs to be undertaken in a way that reflects the characteristics of grounded theory which are summarised by Strauss and Corbin(1998) as:

- Situations have been critically analysed upon reflection
- Bias has been recognised
- Criticism has been accepted and flexibility incorporated
- Interpretation of both words and actions have been dealt with sensitively

To try to achieve this, interviews were used as the methodology for phase 2 as they provide richer and more detailed data and allow for the above points to be utilised during analysis. Interviews undertaken were semi-structured and specific questions were identified, but the interviewee was free to respond therefore being unrestricted and allowing for flexibility in the replies.

At this stage of the research project it was identified that it may be useful to compare the findings of this approach to data collection with responses gained using an international comparison. The rationale for the choice of country for the comparative study is given in 5.1.2., and the hypothesis developed for this aspect of the research which required testing was:

'In Australia there will be a much greater focus on environmental issues and sustainability in construction management programmes because damage to the environment is much more evident there than in the UK'

5.1.1 UK Sample

The nature of this type of data collection relies on quality as opposed to quantity and therefore it was necessary to reduce the original sample size down to a workable number and to achieve this, a cluster analysis based on a sampling grid was used. The following questions were identified from the phase 1 study programme leader questions as the most relevant to the research:

1. Do they have a programme expected learning outcome that has an environmental focus?
2. Do they have an integrated approach to the teaching of environmental issues?
3. Would you consider increasing the amount of environmental content in your programme?
4. Is the programme viable in the long term?

The responses to these questions are shown in table 5.1

University	1	2	3	4
A	***No***	***N***	Y	Y
B	***No***	***N***	***N***	Y
C	**Yes**	**N**	**N**	**N**
D	**No**	**Y**	**Y**	**N**
E	Yes	Y	Y	Y
F	***No***	***N***	***N***	Y
G	Yes	Y	Y	Y
H	***No***	***N***	Y	Y
I	***No***	***N***	***N***	Y
J	Yes	Y	Y	Y
K	***No***	Y	Y	Y
L	Yes	***N***	Y	Y
M	***No***	Y	Y	Y
N	Yes	***N***	Y	Y
O	Yes	Y	Y	Y
P	***No***	Y	***N***	Y
Q	Yes	Y	Y	Y
R	**No**	**N**	**Y**	**N**
S	Yes	***N***	***N***	Y
T	Yes	***N***	***N***	Y
U	Yes	***N***	Y	Y
V	Yes	Y	Y	Y

Table 5.1 Summary of responses to four key questions from phase 1

The courses highlighted in blue were unviable due to imminent closure and were therefore excluded from the sampling process.

Questions 1 and 2 are deemed to show that the programme team have considered the inclusion of environmental issues in their programmes already, and therefore these two questions were used as the initial basis for choice as subjects. However as the author wished to determine whether or not there are differences in the programmes and the different approaches that are taken, it was deemed inappropriate to use in the sample all the institutions that stated Yes/Yes to questions 1 and 2 as these will be the institutions that are already proactive and may not represent the true situation. The cluster analysis was therefore prepared by grouping Yes/Yes, Yes/No, No/No, and No/Yes responses to these questions.

Yes/Yes	**Yes/No**
E ***G*** ***J*** ***O*** ***Q*** ***V***	***L*** ***N*** S ***T*** ***U***
No/Yes	**No/No**
K ***M*** P	A B F H I

Table 5.2 Cluster analysis results

The research is focussing on how programmes will change in the future, and therefore willingness to change by the programme leaders is of paramount importance. A Yes response to question 3 was deemed to be necessary and the programmes highlighted in blue and italics, gave a Yes response to this question.

In both the No/Yes and No/No categories there were only two institutions that satisfy the criteria and therefore they were approached to be a part of the sample. In order to ensure that the sample was equally balanced, the same number of institutions that answered Yes to question 3 was taken from the Yes/Yes and Yes/No respondents (2 from each). In the Yes/No category there were three institutions that satisfied the criteria, and in the Yes/Yes sample as was to be expected, all stated yes to question 3.

There was little to distinguish between these in so far as choice was concerned, as they all have a long tradition of construction management education. Therefore the choice was made by the enthusiasm of the programme leader to be involved in the project. In total eight interviews were undertaken.

5.1.2 Rationale for international comparison

Avoiding environmental damage is a global issue, and the effects of one country's environmental attitudes can affect the whole world. Therefore if theories of good practice of curriculum design are to be developed, some international input is desirable.

The initial consideration for the choice of country for comparison and input to the research was language. In order to undertake any literature review and data collection, only English speaking countries were therefore considered. An initial review of literature resulted in the finding that Australia had the most in common with the UK, and this line of enquiry was then pursued. In addition an exploratory interview was arranged with an ex-Professor of Architecture from the University of Canberra, now based in the UK. The interview and the review of various Australian industry reports produced the following findings:

5.1.2.1 Similarities between the UK and Australian Construction Industries

1. The level of construction work is growing in both countries, especially in the residential sector due to:

- Population growth
- Population movement
- Increasing number of elderly people
- Reduction of interest rates
- Increases in wages and spending power

2. There is also a significant amount of speculative activity particularly in the building of office blocks and hotels in both countries and factors for this include:

- Changes in industrial structure such as the increase of service industries and the relative decline of manufacturing
- Population growth
- Infrastructure development

3. Labour productivity is high in Australia, in fact second only to the UK (Australian Constructors' Association, 1999). In terms of productivity Australia and the UK were the nearest in the sample of countries surveyed for the report. In

Australia it was 3% less than in the UK, 4% above Sweden, 10% above the USA and 40 to 60% higher than in Japan and Germany

4. Australia and the UK have comparable health and safety records (Australian Procurement and Construction Council, 2002)

5. Construction employment levels are low in Australia as in the UK despite high levels of construction output.

6. There is strong competition at all levels in the industry and overall construction prices are very competitive in both countries, and low as opposed to Germany and Japan that are very high.

One quote made in the Australian Procurement and Construction Council report of 2002 regarding the competitiveness of the Australian industry can be directly related to the UK industry:

'Competition is a way of life in the Australian construction scene. The market is relatively small, the barriers to entry for new players are low and competition from overseas companies is unrestrained. There is no protection for Australian construction companies and projects are won on the ability to satisfy a client's needs'

A further comment was made, which could again be a quote made about the UK industry regarding the effect of competition on the amount of research being undertaken by industry:

'Intense competition has led to reductions in costs due to refinements and construction methodology on a project by project basis. The downside has been the reduction in research and development personnel being employed by companies which were directed toward improving productivity across the whole of the company activities'

7. The Australian Construction Industry uses specialist subcontractors in a similar way to the UK as this reduces risk to the main contractors, but this does create issues concerning health and safety, training and environmental management.

8. Prefabricated construction technologies have become widespread in recent years in Australia and are similarly increasingly being utilised in the UK.

9. There are significant similarities in the structure and nature of the construction industry

10. Australia has high productivity; high skill levels, long working hours and high hourly wages as in the UK

11. Australia has embraced the principles of Local Agenda 21 (LA21) (Khan and Bajracharya, 2005) and all Local Authorities have LA21 policies. This is mirrored in the UK, although in Australia there is a belief that this is having more impact than in the UK, especially with regards to planning strategies.

12. The Australian Institute of Building is affiliated to the Chartered Institute of Building and as such has a similar role to the UK based organisation in setting and maintaining professional standards.

5.1.2.2 Differences between the UK and Australian Construction Industries

1. In Australia wages paid in the Construction Industry are high compared to other industries, which is not the case in the UK especially at the management levels. The following quote was made in the Australian Procurement and Construction Council Report (2002):

'Australian education and respect for learning drives our management skills to be leading edge. The desire to learn, to experience and to seek knowledge is an Australian characteristic which is paying dividends in Australian management. The nation has a great pride in its construction achievements and high calibre young people that are drawn to the industry. Today we see many of our brightest young people turning to engineering or construction as their chosen profession'

In the UK Universities have problems recruiting students onto construction related courses as evidenced by the findings of the telephone interviews undertaken with programme leaders in the UK (this is not the case in 2007, but was very much the situation in 2002).

2. Australia has a high level of industrial disputes. In the UK industrial tensions have been contained by limiting the role of unions.

3. From an environmental perspective there have been marked improvements in the level of benchmarking of environmental practices using Key Performance

Indicators in Australia. The data shows an increase of benchmark scores from 13% in 2001 to 41% in 2002.

The most frequent user of environmental criteria was the civil infrastructure sector at 45% followed by the non residential sector at 39% and residential sector at 35%. These figures indicate that the public sector is the most proactive as far as environmental benchmarking is concerned which is different from the findings of the survey undertaken in the public sector in the UK. To a certain extent it could be expected that the Australian industry would take environmental issues more seriously than the UK as the effects of environmental damage are more visible to them. The occurrence of skin cancer in Australia is rising dramatically due to the hole in the ozone layer caused by environmental damage for example.

4. There are a lot of problems with materials deliveries in Australia because of the distances involved. Therefore there is a tendency to use locally produced materials which supports the definition of sustainable construction (Minter Research, 2002).

5. The diverse climate could affect the curriculum at the different Universities because of the diversity of climate. For example Tasmania and Queensland are more environmentally proactive, because they are most affected by environmental problems. This is not the case in the UK because the climate is relatively uniform.

These initial findings have been considered and because of the number of similarities it is deemed a suitable sample for the research project. The differences are also important because the nature of them leads the author to believe that in Australia there is more proactivity in promoting sustainable practices than in the UK.

The following research hypothesis will be tested via the analysis of the data collected.

'In Australia there will be a much greater focus on environmental issues and sustainability in construction management programmes because damage to the environment is much more evident there than in the UK'

5.1.2.3 Australian Sample

In order to make suitable comparisons between the UK and Australia the research primary data needed to be collected from institutions with the same qualifications as those used in the UK.

The institutions targeted in the UK were those that run Construction Management undergraduate degrees that are accredited by the Chartered Institute of Building. As such the Australian Institute of Building was contacted and they kindly provided a list of institutions that run courses accredited by them. There are eleven in total, and these were all contacted via e-mail. Eight institutions responded positively to being involved in the project. The location of these universities is shown in table 5.3.

A	Sydney
B	Newcastle
C	Brisbane
D	Adelaide
E	Melbourne
F	Melbourne
G	Melbourne
H	Perth

Table 5.3 Australian sample

A visit was undertaken to each of these institutions and the same interview questions were used when interviewing the programme leaders in Australia as were used in the UK. The diversity of location of these institutions was important as it was envisaged that there would be differences in the curriculum and approaches to design and construction in the different areas. The locations of the institutions are shown in figure 5.1

Figure 4.1 Location of Australian Universities in phase 2 sample

Figure 5.1 Location of Institutions in Australia used for phase 2 data collection

5.2 Research Methodology and Design

5.2.1 Questionnaire Design and Implementation

There was so much background information that could be gained that implementation problems were envisaged as to how to compare different programme leaders perspectives of these issues. In depth interviews can generate a large amount of data and allow for immediate follow up questions, clarification of points and exploration of meanings. Therefore although the majority of the interview was exploratory, there were some attitudinal questions. Here the perception of the interviewee was asked for on certain issues whether they agreed or disagreed and in some instances they were asked to rank various elements as to the impact they may have on the curriculum. A copy of the interview question sheet is included in the appendices.

This aspect of the data collection and subsequent analysis is the quantitative aspect of what is predominantly a qualitative approach and its use is supported by the previous validation of the use of a mixed methodology.

The questions used were designed to encourage the interviewee to answer freely and as little intervention by the author as possible occurred. Moser and Kalton (1983) suggested that there are three conditions required for a successful interview, accessibility, cognition and motivation of the interviewee.

As all of the participants had agreed to undertake the interviews, they arranged suitable accommodation for the interviews to take place and they were highly motivated which was evidenced by their enthusiasm to be part of the research project. As programme leaders of construction management programmes with many years experience, they were all highly cognisant with the basic information required from the interviews.

The questions asked have been grouped and the rationale for each group of questions and method of analysis for each group of questions is shown in table 5.4.

Background(person) How long have you worked in education? What was your experience in industry? Do you have a specific research interest?	These questions were asked to ensure that interviewees were suitably experienced in HE, and knowledgeable in construction related fields. The final question was asked to ensure that the sample was not made up entirely of environmental researchers.	These responses were tabulated and checked to ensure that all interviewees were suitable.
Background (institution) How many courses are accredited by the CIOB? What are they? Number of students on CM course Demand for the programme(s)? Are they mixed with other groups? Does this have positive or negative effects?	The main focus of these questions was to assess opinions on multi-disciplinary teaching and learning	These responses were coded and coding results read in conjunction with spoken text.
Approaches to curriculum design How are environmental issues incorporated into your curriculum? Where in the curriculum are they appearing? Are you happy with the extent to which the environmental issues are incorporated? Fragmented or Integrated approach? How do you know?	The main focus of these questions was to identify the level of environmental issues incorporated in programmes and where the main focus for sustainability was, subject wise.	These responses were coded and coding results read in conjunction with spoken text.
Student knowledge requirements In the professions that your graduates will be employed in, what are the main things that students need to know after completing their degree, from an environmental perspective? Should their knowledge be: • Generic or specific • About Sustainability generally. • About Sustainable	These questions were asked to identify what students need to know about sustainability on graduation and if this knowledge will have any impact on construction practice in the future.	These responses were coded and coding results read in conjunction with spoken text.

development, that includes social issues • Focus on Sustainable design • Focus on Sustainable construction Will this knowledge enable real changes to be made to industry practices? Why?		
<u>Student attitudes</u> What are the students' attitudes to the inclusion of environmental issues within the programme? Do attitudes change as they progress through the course? How do you know this? Is there any evidence?	These questions were asked to assess student attitudes to sustainability in the context of construction and buildings. The literature review identified that knowledge can change attitudes, that could then change behaviour. This and the previous set of questions were aimed at identifying whether the programme leaders believed this to be the case.	These responses were coded and coding results read in conjunction with spoken text.
<u>Curriculum flexibility</u> Is there anything that prevents more inclusion of environmental issues? Are you happy with the amount? How does your curriculum develop?	These questions were asked to identify approaches to curriculum development and also identify any barriers that prevent further inclusion of environmental issues	These responses were coded and coding results read in conjunction with spoken text.
<u>Stakeholders</u> Do you agree or disagree with the following, why and do you have any examples: You develop Expected Learning Outcomes and then develop level outcomes, and then module outcomes? The curriculum is generally Input driven? Industry has a lot of influence on curriculum content? The IOB framework is the main influence on the curriculum? Staff research interests influence the curriculum How would you rank the following on a scale of 1 to 5 regarding potential influence on the curriculum in the future: EU parliament, UK government Local government, CIOB/AIB, Industry University itself, Staff, Students	These questions were asked to identify who are the main stakeholders in curriculum design, and why this was the case.	As these were one word answers, the responses have been tabulated and conclusions given after basic calculations of means and modes.
<u>Programme leaders perceptions of industry approaches to sustainable design and construction</u> For the following definitions do you	These questions were asked to identify if programme leaders believe that students need more	As these were one word answers, the responses have been tabulated and conclusions given after

agree strongly, agree, disagree, disagree strongly and why? Sustainable construction is just a fad, hence it will go out of fashion so there is not much point in us focussing on it too much Utilising sustainable construction techniques is not something that industry is really interested in so we don't need to worry too much about it The main reason that industry doesn't 'green itself is because it will cost them money to set up EM Systems. However maybe in the future more clients will be asking questions about the environmental performance of contractors Sustainability and environmental issues are of vital importance in the construction industry because of the impact that construction work has, so it is of vital importance that our students know about these issues Sustainable construction is simply good management, what's all the fuss about, teach students to be good managers and they will utilise these principles in their everyday work	environmental knowledge because the industry is serious about changing to improve sustainability in construction and buildings.	basic calculations of means and modes.
Confirmation of responses and future developments 'Where in your curriculum is the development of environmental literacy most strongly promoted? What are the elements of curriculum design that you think best promote the development of environmental literacy? What have been the most powerful influences on the curriculum content we have been discussing, with regard to the inclusion of environmental issues? What do you see as the possible major curriculum changes in the future and why?	These questions were asked to confirm and clarify earlier answers if necessary. The important question here relates to potential future developments.	These responses were coded and coding results read in conjunction with spoken text.

Table 5.4 Phase 2 analysis -Questions asked, rationale for the questions and method of analysis

5.3 Data analysis

5.3.1 Detail of methodology for analysis

A mix of open and closed questions was used in the interviews to allow for clarification and elaboration to take place on dichotomous questions and therefore allowing for quantitative and qualitative data analysis. The quantitative data was analysed very simply by using means and modes. The use of statistical testing tools for analysis of this data is invalid because of the small number of responses (16 maximum).

The most commonly used approach for qualitative data analysis involves examining the content of replies through coding. Charmaz (1983) described qualitative coding as creating categories from interpretation of the data and Strauss and Corbin (1990) identified codes as not denoting facts but breaking up the data. Coding was adopted as the main method of analysis, but there are different approaches to coding. Two abortive attempts to analyse the data were undertaken, firstly using the interpretative research paradigm method as advocated by Berry (1998) and secondly using the manual open coding method followed by axial coding as defined by Strauss and Corbin (1998).

5.3.1.1 First strategy

An initial review of potential analysis tools led to the discovery of a method based loosely on coding that had been used to analyse educational qualitative survey data that had been developed by Berry (1998). The methodology is termed the interpretative research paradigm, and the central concern of this method is understanding human experiences at a holistic level. Researchers of this kind interpret the complexities embedded in these experiences to seek meanings and illuminate their significance. Ernest (1994) states that:

'The interpretative research paradigm is primarily concerned with human understanding, interpretation, intersubjectivity, lived truth (i.e. truth in human terms).'

Interpretative research is often conducted in natural settings, and thus is sometimes called naturalistic inquiry and the broad focus is initially open-ended, allowing for important meanings to be discovered or uncovered (Maykut & Morehouse, 1994).

The approach requires the identification of core variables and Hutchinson (1988) suggests a way to identify the core variable, as follows:

'The core variable has three essential characteristics: it recurs frequently in the data; it links the data together; and it explains much of the variation in the data. This variable becomes the basis for the generation of the theory. The categories, properties, phases, and dimensions of the theory are inextricably related to the core variable.'

The main concern of Berry (1998) was to discover how a group of Hong Kong Chinese students learn English and to understand their English learning experiences in a natural setting. She used in-depth interviewing as an instrument for narrowing down the investigative focus and then the interpretive research paradigm approach to analysis of the resulting data. This method required identifying themes from the transcription of the first interview and counting up the number of times the theme is referred to. Then moving onto the next transcript and identifying how many times the theme was referred to, and also adding new themes that were raised in the second interview. The same was then undertaken with transcript three and more variables added etc.

Her project consisted of five interviews and she started with nine variables after interview one was analysed and this rose to twenty two variables after interview five. This approach was deemed to be suitable for the analysis of the qualitative data collected in phase 2 and an initial attempt was made to analyse the first interview undertaken in the UK using this method.

Table 5.5 shows the initial themes and variables that emerged from undertaking this approach.

Variables which emerged in interview 1	**No. of incidences found**
Environmental content is increasing over time	1
Environmental issues are topical that is why they are included in the curriculum	1
Environmental issues are mainly included in technology	1
Environmental issues are mainly included in management	2
Waste issues included-money saving perspective	4
Waste issues included-environmental perspective	1
Environmental issues are integrated into the curriculum	2
Modularisation discourages integration	1
Better to include specific modules	1
Education is ahead of industry from environmental perspective	2
Industry is not proactive	1
It is easier to have more control of the curriculum with a small teaching team	2
Construction students only need an appreciation of green design	1
There is a clear link between knowledge and attitudes of students	1
Problem based learning best promotes environmental literacy	1

Table 5.5 Variables identified in interview 1.

A number of concerns were raised after this exercise was undertaken:

- Berry had identified fewer variables in the first interview, with more 'hits' per variable.

- The number of variables that could potentially develop using the increase in variables that she identified on a pro rata basis (an increase of 150%, 37.5% per interview) could lead to as many as forty for this research project. The development of this number of variables along with the low number of 'hits' made it very difficult to identify themes.

After reviewing Berry's paper again, the cause of the problem was revealed. Her questions were much tighter and less open than those used for this project and because the subjects of her study were much younger than those in this study, there was more guidance to the answer given in the questions and also the questions were often repeated in different forms of words.

After careful consideration, this methodology was rejected as a method of analysis for this phase of the work because approaches taken to the interview design and interview techniques were different.

5.3.1.2 Second strategy

Elements of the interviews were analysed using a qualitative approach initially through manual open coding followed by axial coding of the responses, and connections were made allowing structures in the data to be explained. Kelle (1997) identified this as both an abductive and inductive process. Through induction particular empirical phenomena can be explained or described by considering it under an already existing category and through the process of abduction, new and unknown concepts can be found based on irregular events. Open coding is named so, because to uncover, name and develop concepts, the text must be 'opened' up to expose the thoughts, ideas and meanings contained therein (Strauss and Corbin, 1998). In open coding, data are broken down into discrete parts, closely examined and compared for differences and similarities. This is different from axial coding that is the process of relating categories to their subcategories and termed axial because the coding occurs around the axis of a category, linking categories at the level of the properties and dimensions. Axial coding is usually undertaken after open coding because open coding is required to set out the properties and dimensions of a category. Open coding allows the data to be fragmented and axial coding allows it to be reconstituted and concepts further developed.

The transcripts for question 1 of the interview were coded for both the UK data and the Australian data. The coded transcripts are included in the appendices (CD) and a summary of the findings of the coding are given in tables 5.6 and 5.7.

	No of times mentioned	No of interviews mentioned
Integrated/integral/ integration/ threaded/ threads	8	3
Management	11	5
Technology	9	6
Materials/disposal/waste	7	5
Sustainable/sustainability	4	2
Green	3	2
Core	1	1
Safety	10	4
Services	2	1
Elective/option/choice	2	2
Ethics/Ethical	1	1
Legislation	4	1
Science/scientific	3	2
Programme	0	0
Modules/subjects	21	6
Refurbishment/demolition/reuse	2	1
Cost/ money	4	3

Table 5.6 Coding results for question 1- UK interviews

	No of times mentioned	No of interviews mentioned
Integrated/integral/ integration/ threaded/ threads/incorporated/infiltrate	6	6
Management	5	3
Technology/construction	11	5
Materials/disposal/waste	3	3
Sustainable/sustainability	7	2
Green	0	0
Core/specific	0	0
Safety	0	0
Services	3	1
Elective/option/choice	1	1
Ethics/Ethical	2	1
Legislation	1	1
Science/scientific	3	2
Programme/course	3	3
Modules/subjects	24	7
Refurbishment/demolition/reuse	0	0

Table 5.7 Coding results for question 1- Australia interviews

After axial coding had been used in an attempt to develop categories from the subcategories, the main conclusions that could be made from the UK coding information were:

- Integration mentioned eight times but only in three interviews therefore highlighting that the need to integrate as dictated by the educational framework is not being taken on board universally. Modules/subjects mentioned 21 times in six interviews which supports this statement.

- More mention of technology than management but the programmes are all construction management programmes and therefore more focus should be on management. Contradicts the findings of the student questionnaire where students were actually more knowledgeable about environmental issues from a management perspective.
- Evidence that academics link environmental management to waste control.
- Very little mention of sustainability generally.
- Some evidence of linking environmental and health and safety issues as recommended by the educational framework.
- Hardly any mention of building services and/or refurbishment which are a major factors in achieving sustainable design.

The main conclusions that could be made from the Australian coding information were:

- Integration mentioned six times in six interviews therefore highlighting that integration of environmental issues is preferred to fragmentation. BUT Modules/subjects mentioned 24 times in 7 interviews which does not support this statement.
- More mention of technology than management but the programmes are all construction management programmes and therefore more focus should be on management.
- No real evidence that academics link environmental management to waste control.
- Very little mention of sustainability generally.
- No evidence of linking environmental and health and safety issues as recommended by the educational framework.
- Hardly any mention of building services and/or refurbishment which are a major factors in achieving sustainable design.

The author was however uncomfortable with these results and believed that the thrust of the discussions with the programme leaders were being distorted.

Therefore this method of analysis was deemed to be unsuitable and another method needed to be identified.

5.3.1.3 Third strategy and method of analysis used

The failure of the two methods of analysis of the data proved frustrating, and required further investigation to find a method of analysis that would better suit the data collected for the project. The third strategy to be tried involved the use of NVivo software and this proved successful. Taking the advice of Bazeley and Richards (2000) the tools of the software were learnt as and when needed. They advocate this approach and state that:

'Qualitative software is often best learned that way, since qualitative projects normally unfold; as more data are discovered or created, more ideas are formed, more hunches and theories constructed and tested, and more inquiries built on those first ideas. Doing qualitative research with software does not require a full knowledge of all the tools at once. So long as you know that you will not create future problems, or limit future choices, you can get on with a project and get to know the software as you go'

The principles of NVivo are based on coding as has been previously discussed. To use it in its purest form, the software would be used to open code and then axial code, which is a totally qualitative approach. However it can also be used to open code only by developing nodes (coding categories) and then use the two levels of explanation defined by Strauss and Corbin (1998) to analyse the results: a. the actual words used by respondents and b. our conceptualisation of these derived from the coding. This approach requires elements of qualitative and quantitative analysis that supports that idea that this research project employs a mixed model methodology approach to the collection and analysis of data.

The transcripts of the interviews undertaken were converted into rich text format files and imported into the NVivo software. The software was then used to isolate the responses question by question. This enabled node coding reports to be developed for each question and made open coding much simpler. Categories were identified from the responses and codes developed.

The subsequent summary sheets of the analysis identified how many times these categories had been discussed and/or mentioned in each response. The discussion of the results of this coding and interpretation of individual statements form the basis of the analysis of this data.

5.3.2 Results of the analysis of data and international comparisons

5.3.2.1 Validity of Sample

Tables 5.8 and 5.9 summarise the number of years experience, their background experience, whether they are a member of the Chartered Institute of Building and research interests for both countries.

	I1	I2	I3	I4	I5	I6	I7	I8
No. of years worked in HE	15	10	30	22	16	18	9	12
Background	CM	QS	CM	CM	CM	CM	QS	CM(LA)
CIOB member	Y	Y	Y	Y	Y	Y	N	Y
Research interests	Rapid PDP	Financial management Of contracts	Precast concrete Public housing	Quality and supervision	WBL Motivation and communication	Health and Safety PFI	Health and Safety	Waste Management Off site performance on cons. companies

Table 5.8 Experience, background, professional body membership and research interests (UK sample)

	I1	I2	I3	I4	I5	I6	I7	I8
No. of years worked in HE	15	10	12	10	14	25	8	20
Background	CM	QS	CM	CM	CM	QS	CM	CM
CIOB member	Y	Y	Y	Y	Y	Y	Y	N
Research interests	None	Procurement and Construction Economics	Selection of clients	Intelligent and sustainable construction	Project Management	Design Economics	Environm-ental Impact of constructi-on	Timber frame housing ,educat-ion

Table 5.9 Experience, background, professional body membership and research interests (Australian sample)

The UK programme leaders had 132 years experience in higher education whilst the Australian programme leaders had a total of 114 years. All the interviewees had worked either as Construction Managers or Contracting Quantity Surveyors and as such had excellent knowledge of industry practices. All but two were members of the Chartered Institute of Building and/or the Australian Institute of Building. Only three interviewees stated that there main research activity was related to sustainability, but this is deemed to be a positive aspect because if all the interviewees were interested in the environmental impacts of construction work and buildings, the sample would be distorted from the total population of programme leaders.

The interviewees in both the UK and Australia were deemed to be suitably qualified to enable successful interviews to take place. The interviews were all taped, transcribed and each interview lasted approximately 90 minutes.

5.3.2.2 Background (institution)

All the universities had at least one programme accredited by the CIOB/AIB and in all cases this was Construction Management or a very similar derivative of that title. Universities in the UK generally had more programmes accredited and running than the Australian universities and this was because of the downturn in recruitment at the time that had led to the development of new programmes. The most popular courses that had been developed were Quantity Surveying and Architectural Technology. The Architectural Technology programmes will have a high element of design in the curriculum. Regarding numbers of students on programmes, the results for the UK and Australia were very different and support the statements made in sentence two. UK universities at this time were finding it very difficult to recruit students with on average, sixty students across all years and all levels of study. In Australia they were recruiting well and on average recruiting up to a hundred in the first year only.

Demand for the programmes reflected the number of students and was relatively low in the UK but extremely high in Australia. In the UK a number of the universities responded that Construction Management was still viable, only because the students shared modules with students on other built environment disciplines and that this was a trend that was developing for other programmes that were being validated.

With regard to interdisciplinary study, in the UK this was extremely common especially in the sharing of lectures. The general consensus was that in level 1 all teaching was common, in level 2 this reduced to around 75% and then further to around 50% in level 3. The construction management students shared modules with a large number of quite diverse built environment programmes. However in

Australia this was very different and if there was any interdisciplinary study at all it was with architects or quantity surveyors. There were no common elements at all in level 3.

In the UK universities, feelings about the benefits of interdisciplinary teaching were mixed. Negative effects were felt to the loss of cohort identity and the tendency to have to go very wide in the delivery of a module so that all disciplines requirements are covered. This causes a lack of depth that used to be delivered before modules were shared. The other negative aspect was that students do not generally see the benefit, all they see is themselves being one of a very large group and getting less attention than they should, teaching staff not knowing who they are and feeling hesitant about asking questions in such a large group. On the positive side, it was identified that this approach was beneficial because it reflects the nature of the industry with people of all disciplines working together, but, one respondent stated that just because students sit in a lecture together that does not mean they talk to each other and learn about each others discipline. In the UK the general consensus appeared to be that interdisciplinary study was interpreted as shared teaching with students on other programmes. There was no mention of students undertaking projects together and learning together. The approach appears to have been adopted with the aim of increasing efficiency of teaching and maintaining programme viability.

In Australia there was much less common teaching and the perceptions of the benefits of interdisciplinary learning were more anecdotal from previous years and to a large extent mirrored the UK perceptions. The major difference in the Australian findings that was not mentioned in the UK was that amongst the student body there was a perception that courses such as architecture were superior to other programmes, with construction management being one of them. This was mentioned in three interviews and cited as a reason why they do not work together well. This is very worrying because this can then reflect their attitudes when they graduate and start work in the industry which will enhance the adversarial nature of the industry.

The major conclusion from this section of data is that interdisciplinary approaches have been adopted in the UK mainly for logistical reasons as opposed to educational reasons. However the UK programme leaders were much more positive about the potential of this development and may have been influenced by the Latham Report (1994) which advocates 'building the team'.

5.3.2.3 Approaches to curriculum design

In the UK all construction management programmes have an environmental science module, or similar, at level 1. This is because the CIOB educational framework asks specifically for this. However from the responses of the programme leaders, to argue that this covers environmental issues in the context of construction work is inaccurate, but it is relevant for giving background information for sustainable design. All the interviewees stated that environmental issues were integrated in many modules, particularly construction technology and construction management. In construction technology the emphasis is mainly on choice of materials that are specified for different building types and in construction management is mainly on waste management. Therefore although the respondents stated that it was integrated, actually the focus is very narrow-materials specification and reduction of waste. Several of the programmes have modules, or parts of modules, that are devoted entirely to environmental issues.

The main finding of this section was that although the programme leaders believed that sustainability was integrated, they could not prove it and evidence was mainly anecdotal. They insinuated that if evidence of this was required via documentation, then this would not be possible.

They also stated that integration was not enough at this time and one of the respondents believed that even though sustainability should be integrated like health and safety as the educational framework promotes, in reality the only way to raise the profile was to develop bespoke modules as they had done for health and safety.

The Australian data identified that in their programmes there is much more structured integration of environmental issues in addition to every programme having bespoke environmental modules. At one university, for each module, certain criteria have to be identified as to where and to what level they appear. These criteria include communication skills, numeracy skills, IT skills etc. and one criteria is addressing environmental issues.

In the UK sample problems associated with modularisation were identified. Following is a direct quote from one interviewee:

'We all know the problem with modular degrees and modules, and how it separates out the subjects but doesn't link them. You almost need one module to pull them all together, but you don't if you spread all the issues into the modules'

He was concerned that if you do not have a discrete module to bring all aspects together, all the lecturers try to cover everything in every module. In this scenario every module becomes the same with a slightly different focus or the amount of environmental issues covered in a module will reflect the level of environmental persuasion of the lecturer. Those that are interested will incorporate them, those that are not, will not. Worryingly the indication is that there is no policing of this mentioned in any interview.

There were differences between the approaches adopted in both countries with universities in both countries stating they had fragmented approaches and some stating they had integrated approaches. In the UK data set this contradicted the statements they had made earlier, where it was obvious that even if they stated they had an integrated approach, they would not be able to prove this and from the descriptions of where the integration took place it is very limited.

In the Australian data set this was also contradicted but for a different reason because from previous answers it can be deduced that they use the dual approaches of integration and fragmentation more often.

The responses to the question 'Are you happy with the extent to which environmental issues are incorporated in your programme?' prompted some very interesting responses summarised below. The UK responses were:

'I am, yes, we are well ahead of the industry, it is industry I am not happy with, not the course'

'We could always do more, but considering the ever increasing base of the curriculum then a balance needs to be struck'

'We could do more, but some of my colleagues would argue that they can't deal with those issues because they do not know about them'

'Yes, because I am absolutely paranoid about it not going over the top'

'I would say no, because there is no way in which it is controlled or organised'

These statements are interesting for a number of reasons. One is demonstrating a very strong belief that the industry is not proactive in this area and that graduates of today's programmes will be far more knowledgeable in sustainability issues than those currently employed in the industry. One statement purports to the fact that the educational framework is ever increasing and it will be impossible to 'fit more in'. Two of the statements support the argument that staff lack of enthusiasm and knowledge is a barrier to increasing and improving the content of sustainability in programmes and the final statement can be interpreted as meaning that if integration is the only route used it is not monitored effectively and therefore may not happen. An element of fragmentation is also required that can be controlled.

Although the Australian programme leaders were generally happier with the amount of environmental content, there were the same issues raised in some of the interviews:

'the AIB is happy with the element of our coverage, but in the long term I think certainly we can do more' (restriction by professional body requirements)

'Yes, but some people would say I am negative against sustainability because I have other priority areas' (lack of staff interest)

'I don't think as a group of staff we understand the full extent of the environmental topics that we could be dealing with' (lack of staff knowledge)

'I think it is technically quite difficult and I am reluctant to see people jump in and do simplistic stuff' (lack of staff knowledge)

5.3.2.4 Student knowledge requirements

The UK programme leaders all believe that waste management on site and during production of components to be crucial if the construction industry is to improve its performance and therefore students need detailed knowledge of how this can be achieved. When three respondents discussed waste, they also referred to loss of heat transfers as waste during the life of the building and that this was linked with knowledge of sustainable design. One respondent stated that they had included studies of waste management practices in Australia and cited these as good practice. A good summarisation of what the programme leaders believe students need to know is:

'It's just a fundamental understanding of the environmental impact of a building in the building process and throughout the life of the building'

It was also stated that students need to know more about the global impacts of construction on the environment. Discussing sustainability at a module level sometimes means that concepts are delivered out of the broader context.

The Australian interviewees concurred with the UK respondents in stating that waste management is the major issue that needs to be addressed in the curriculum and they also highlighted the need for students to know how to reduce dust and noise during construction work. There was also more emphasis on the building design and life cycle of buildings in their responses and the need to ensure that students know solutions to building problems that will reduce energy loss and pollution over the life of buildings.

However one respondent stated that issues of sustainable construction should be in the postgraduate as opposed to undergraduate arena. He thought that 'you can dabble' in the undergraduate course and that there is not enough space in the curriculum to address these issues in enough depth. He then stated that not many students go on to do postgraduate degrees, and if it is acknowledged that to facilitate change then the majority of professionals in the industry would need to have at least some knowledge of sustainability, then this would be a problem.

With regard to whether student knowledge regarding sustainability should be specific or generic, there were mixed responses and some very interesting perceptions.

The following statement refers to students' backgrounds in a non-specific way:

'Our students are from a generation coming through that are far more environmentally conscious, they are almost automatic re-cyclers which we are not'

This statement was used to support the argument that students know about the generic issues relating to the environment, and therefore the focus in construction management programmes should be specifics. The general consensus was that they needed generic knowledge to be able to put more specific knowledge in context. This supports the idea of using a fragmented approach where generic issues related to the environment are relayed, and an integrated approach where specific aspects related to core disciplines can be explored.

The Australian view was very similar to the UK view on this aspect and for both groups they identified good ways of applying this knowledge using case studies and projects, especially at final year level.

In both countries the idea of including social issues relating to sustainability were deemed to be less important, except that students should appreciate the contribution of construction work and buildings on a wider scale. This does not just mean from the negative energy use, pollution causing, resource depletion perspectives, but also from a positive side.

One very interesting quote that was deemed to be inspirational for the students was:

'Our current chancellor who is Sir Robert Winston, addressed us at last year's graduation ceremony and said that he has been in the medical profession for his entire career, but the audience here has more impact on the health of the nation via the provision of clean water, provision of drainage, change of living conditions etc. than the medical profession does'.

There was an undercurrent in the responses that related to time available in the curriculum to include social issues, and this links back to one of the barriers to improving environmental literacy being the restricted nature of modular degree programmes which have to comply with a tightly defined educational framework.

When asked if the programme leaders thought the programmes should focus on design, the answer was no. However the question was misleading because it was asked if the MAIN focus should be on sustainable design, which is incorrect for a construction management programme. After the initial answers though, it was agreed by the majority that there needs to be a reasonable element of the programme that focuses on design. The reasons for this were that a substantial number of graduates are now going to work for companies that undertake a lot of design and build work so they will have an impact on design choice and specification. And additionally that design should be undertaken with production in mind and therefore it is totally relevant for construction management students to have knowledge of this. However the teaching of sustainable design should not detract away from traditional building processes, because then students would have insufficient knowledge of prevalent construction practices.

The Australian respondents when asked the same question, all responded "yes". The interviewees identified that their students very often graduate into Property Development and as such need design knowledge. This is different from UK construction management graduates who tend to undertake careers in pure construction management. The other difference that may affect perspectives is that in Australia, construction management students are taught more often with architecture students which is much less prevalent in the UK. This will affect the amount of design in the programme.

The question relating to whether or not the focus of a programme should be on sustainable construction had already been largely answered. The respondents in both the UK and Australia believe that the focus should be on core traditional construction management subjects but that there should certainly be a strong bias towards sustainable construction and an element of sustainable design. If there is room for social issues this should be included but detailing of construction specific information is more important than generic information because students are now starting their university studies with this knowledge.

The responses to the final question in this set were very mixed and produced a number of interesting responses as follows:

Question: Do you think the knowledge students get will enable real changes to be made to industry practices with regard to protecting the environment?

'Yes, but it could take a long time and it also relies on people that are leaving the universities sticking to the principles, and the industry not actually polluting them with bad practice'.

'When they get into work I think they just caught up in the culture and ethics and the environmental stance of the company'

'Maybe but it's how the organisation reacts to the person going into it'

These three respondents all seem to think that the individuals' attitudes and behaviour will be influenced by the organisation and that what universities teach them will be 'lost'. This is a very negative stance and is not supported by the data collected in phase 1 that suggested that students who had exposure to the industry, part time and sandwich students, had no difference in attitudes than full time students. Nor is it supported by the research undertaken by Ballantyne et al(2006) who believe that the younger generation are the people who will educate older generations by their conviction that there is a problem that genuinely needs solving. Over time they can use this intergenerational influence to really make significant changes to practice.

More positively and in support of this view, but with some caveats, the programme leaders stated:

'Yes definitely. The only flaw in it is there are not enough construction management graduates to make a real difference'

'Yes, what students learn at university will may raise an awareness to the general issues if they weren't previously aware of them. But, they are construction managers first and foremost and environmental issues follow from that'

'I think that the motivation comes from within them as to how much change they want. I think we would hope that they go with a sort of ethical and social conscience, to go out there and to do things. I think we find they have got it to a large extent when they arrive and we certainly would help them to develop that'.

'I think it is possible but as with all of these things the process of change is extremely slow in that it's a generational thing, things should improve generation by generation'

Although these statements are more positive than the earlier ones, they are still very tentative and there is no total commitment to the idea that students and graduates now will make a difference. The most vehement commentator on this subject is quoted below:

'No, I have got really strong feelings on this. I think that every other industry has spruced up its production. The car manufacturing industry has only been around for about 50 or 100 years but has moved from building cars by hand to building cars using robots. We have been an industry ever since we climbed out of the caves, but what is big for us is like cutting down waste with factory production of truss rafters. I mean with timber framed housing that was seen as innovative, what did we do? Dressed it up and make it look traditional, so the public will buy it'

This statement can be summarised to illustrate two major issues identified by the interviewee:

1. The construction industry does not respond well to change and is slow to develop innovative practices (this could be linked to a lack of applied research in the field of construction, or the lack of desire of organisations to change).
2. The public embrace innovations in most aspects of their lives, for example mobile phones, but when it comes to buildings and in particular homes, they still want traditional forms of construction. This could be because of the expense of homes in the UK, but the challenge to the industry is to develop forms of construction that appear to be traditional, but are designed and constructed using sustainable principles.

5.3.2.5 Student attitudes

Generally in the UK programme leaders believed that student attitudes to the environment are good but in some cases it certainly depends on the student. The responses indicated that the students liked the environmentally themed subjects because they are current and relevant, but also that if something different was focussed upon they would quickly switch interests. However, some of the respondents based their responses on the fact that students did not complain about the environmentally focussed subjects as opposed to them actively stating that they were enthusiastic about them.

The response from the Australian programme leaders was again that attitudes were positive and this reflected the raising profile of environmental issues within the Australian general public. One respondent stated that the student attitudes to environmental issues were one of just having to get on with it, because it is part of what we do- but that there were no missionaries emerging!
Programme leaders in both countries were asked if they believed attitudes change as students progress through the course. This produced very different responses, in the UK all stated yes, as environmental knowledge increases so do positive attitudes. In Australia they all stated no, students arrive with mainly positive attitudes and they just increase their specific knowledge of sustainable construction and design. No reason for this was given except that it could be intimated that Australian students study more generic environmental subjects in

school and evidence of environmental damage is very prevalent in Australia, so they are committed to making changes before they enter university.

Interestingly all these responses were anecdotal and no programme leaders had any evidence to substantiate their claims. In most universities students are choosing environmental themes for their dissertations but not in large numbers.

5.3.2.6 Curriculum Flexibility

There were two overwhelming themes that emerged in the responses regarding any barriers that prevent further inclusion of environmental issues in the curriculum. They are:

- Lack of space in the curriculum, mainly caused by modularisation.
- Lack of staff expertise and enthusiasm to develop expertise

Comments to support these statements included:
'I think modularisation means everything is in small compartments and everyone is trying to cram in their subjects into these small boxes so it is difficult to fit things in'

'We wouldn't want to overload the construction management degree to be too environmentally weighted'

'It is down to what you would take out if you put it in'

'Only space'

'the modular system is the biggest preventer because it doesn't allow you to be as integrated as you would like in the curriculum'

'Two things, room in the curriculum and staff awareness'

'Ignorance from people like me about what it (environmental issues) constitutes'

'We had a great guy who left and he used to give talks to the students and we miss that'

One resolution to the lack of space in the curriculum problem was the idea of 'theming'. It was mooted that if you decided on themes that would run through the programme such as technical, managerial, environmental, social and ethical etc., every subject could be considered under all these themes. This seems to be a very positive approach to curriculum design and is supported by findings of the literature review. In the Australian sample, "time" again was the issue for seven of the eight respondents. One respondent stated that he thought that the balance was about right, but then followed this up by stating that in order to put in more, something would have to be dropped. One of the Australian respondents stated that as programme leader he did not find environmental issues interesting and therefore he did not want to put more in.

Therefore the responses in the UK and Australia were virtually identical with space in the curriculum and staff motivation and expertise identified as the two main barriers for the inclusion of more environmental issues in the curriculum. When asked to verify whether they were happy with the amount of environmental content in their programmes, the consensus in both countries was yes, at the moment but it would probably need to increase over time. This increase could be facilitated with more integration and themeing of programmes.

The next question asked was related to approaches to curriculum development. Generally programme reviews are undertaken every five years, but in the main these involve minor changes. The reviews are undertaken internally where the university structures for revalidation have to be adhered to, for example, module size, regulations etc. When these reviews are undertaken a check is made to ensure that the programmes still map against the CIOB/AIB educational framework. A major impetus in these reviews has been the move to more commonality with other built environment programmes. Another major driver for any major curriculum changes was staff interests. A number of respondents stated that they have industrial input into the programme on an annual basis and this feedback is taken on board mainly at the five year review. Finally there was one respondent that stated that if the external examiner required changes, these may be done on a more ad hoc basis rather than waiting for the five year review. Changes like this tend to only be made if there is something viewed as being fundamentally wrong with a programme, rather than from an improvement perspective. Based on the responses to these questions the ranking of importance of input to curriculum development in the UK are:

1. The University
2 = 3.The professional body and staff interests
4. Industrial input

The response from the Australian programme leaders was very different. They tend to make smaller changes on an annual basis that are generated from industrial input and staff interests. Every five years they have a review but rather than tweaking, they start with a 'blank sheet of paper' and have many discussions as to what the programme should aim to achieve. The ideas for change tend to be linked to staff interests and sometimes the programme leader needs to take a stance to ensure the programme complies with AIB requirements. Complying with university procedures seemed to be a lot less formal than in the UK.

Based on the responses to these questions the ranking of importance of input to curriculum development in Australia are:

1 = 2.Staff interests and industry input
3. Professional body
4. The University

Generally it can be deduced that in the UK an input driven approach to curriculum design is the most common method, whereas in Australia an expected learning outcomes model is what is aimed for, but this can develop into input driven mode if staff interests are allowed to dominate the design of the learning outcomes.

5.3.2.7 Stakeholders in curriculum design

Programme leaders were asked to rank the following on a scale of 1 to 5 regarding their potential influence on curriculum design (1 being very high and 5 being very low. The UK results are tabulated overleaf in rank order:

	I1	I2	I3	I4	I5	I6	I7	I8	
University	**1**	**1**	**2**	**2**	**3**	**1**	**1**	**3**	**14**
CIOB	**1**	**2**	**2**	**3**	**1**	**2**	**2**	**2**	**15**
Staff	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**15**
Industry	**5**	**2**	**1**	**3**	**4**	**1**	**4**	**2**	**22**
Students	5	4	1	3	5	2	1	3	24
UK government	2	3	4	3	5	4	5	2	28
Local government	2	4	4	3	5	4	3	4	29
EU parliament	4	3	5	2	5	4	5	2	30

Table 5.10 Stakeholders in curriculum design (UK)

These figures concur with the findings of the previous line of questioning in their entirety.

Table 5.11 gives a summary of responses from Australian programme leaders:

	I1	I2	I3	I4	I5	I6	I7	I8	
Staff	**2**	**1**	**2**	**2**	**1**	**1**	**2**	**2**	**13**
Industry	**2**	**2**	**1**	**1**	**2**	**2**	**1**	**2**	**13**
AIB	**3**	**2**	**4**	**1**	**2**	**3**	**1**	**2**	**18**
Students	2	2	5	1	3	2	1	3	19
University	**4**	**4**	**2**	**2**	**3**	**3**	**2**	**3**	**23**
State government	4	4	5	3	2	5	3	4	29
Aus government	5	5	5	4	2	5	3	4	33

Table 5.11 Stakeholders in curriculum design (Australia)

These figures correlate with the findings of the previous line of questioning with the first, second and third rated stakeholders as identified earlier. However the university was ranked lower, at fifth place after the students in the Australian responses.

The major differences between the rankings show that in the UK the university itself has a much greater impact on curriculum design than in Australia, probably reflecting the tight control that the Quality Assurance Agency has over curriculum development practice in the UK. In Australia industry appears to have a significant input into curriculum design, whereas in the UK that is less so even though this is advocated as good practice. In both sets of results the professional body and the staff are ranked very highly. This indicates that there is an element of expected learning outcomes curriculum design (professional body involvement) and an element of input driven curriculum design (from staff interests). In both sets of data, government involvement (local, state, national etc.) is very low and as the government had been mooted as one of the stakeholders in curriculum design in the literature review, this was an interesting finding.

In both sets of interviews the responses appertaining to curriculum development for construction management programmes in the UK and Australia can be interpreted and summarised in the following statement:

'A learning outcomes approach to curriculum development is seen as good practice, but in reality (less so in Australia) curriculum development has aspects of both learning outcomes (professional body influences) and input driven (staff influence) approaches. In both countries the top five main stakeholders in curriculum design are the same but in a slightly different order and the reasons for this have already been explained. These stakeholders are the university, the programme team, industry, the professional body and students.'

The questions given in tables 5.12 and 5.13 were asked to give a final clarification of earlier discussions and responses are shown.

	I1	I2	I3	I4	I5	I6	I7	I8	
Is your curriculum developed using a learning outcomes approach	N	Y	N	Y	Y	Y	Y	Y	**Y-6 N-2**
Is the curriculum input driven	Y	Y	Y	Y	N	N	N	N	**Y-4 N-4**
Does industry have a lot of influence on the curriculum	N	N	N	N	N	Y	Y	N	**Y-2 N-6**
Is the CIOB the main influence on curriculum	Y	N	N	Y	Y	N	Y	N	**Y-4 N-4**
Are staff research interests the main influence on the curriculum	Y	Y	Y	N	Y	Y	Y	Y	**Y-7 N-1**

Table 5.12 Curriculum stakeholders verification questions (UK)

	I1	I2	I3	I4	I5	I6	I7	I8	
Is your curriculum developed using a learning outcomes approach	N	N	Y	Y	Y	Y	Y	Y	**Y-6 N-2**
Is the curriculum input driven	Y	Y	N	N	N	N	Y	Y	**Y-4 N-4**
Does industry have a lot of influence on the curriculum	N	N	Y	Y	Y/2	N	Y	Y	**Y-4.5 N-3**
Is the CIOB the main influence on curriculum	N	N	N	N	Y/2	N	Y	Y	**Y-3.5 N-5**
Are staff research interests the main influence on the curriculum	Y	Y	Y	Y	Y	Y	Y	N	**Y-7 N-1**

5.13 Curriculum stakeholders verification questions (Australia)

These responses do verify the earlier statement and there are clearly mixed views as to whether the curriculum design is developed using a learning outcomes approach or an input driven approach. This to some extent validates the claim that a mix of both is used in reality. Staff research interests are clearly a major driver in curriculum design and this supports the earlier statement and also verifies the comment that there is certainly a large element of input driven aspects of the curriculum. This is ranked as higher in these questions than professional body influence. The only surprise in these responses is that the Australian respondents did not claim that the industry had as much influence as had been previously intimated. The UK responses did validate their claim that industry influence was much lower in the UK than in Australia.

The lists given previously in 5.3.2.6 have been revised slightly to take this data into account.

Initial ranking of stakeholder influence (UK)	**Revised ranking**
1. University 2 = 3. Professional body and staff interests 4. Industry 5. Students	1. University 2. Staff interests 3. Professional body 4. Industry 5. Students

Table 5.14 Stakeholders in curriculum design-final UK

Initial ranking of stakeholder influence (Aus)	Revised ranking
1= 2. Staff interests and Industry 3. Professional body 4. Students 5. University	1. Staff interests 2 = 3. Industry and professional body 4. Students 5. University

Table 5.15 Stakeholders in curriculum design-final Australia

Whilst not identical there are some very significant similarities, especially if the very powerful influence of the university in the UK is discounted. The author has experience of validation of programmes in UK universities and believes that programme leaders could perceive this to be the case because universities have very tight controls over rules and regulations but they have little influence over what is actually taught in a programme. Therefore this ranking for UK universities could be perceived by programme leaders because of the level of involvement by the university in the validation process, but it may not be as influential as they think. This would then place staff interests at the top of both lists and is worrying because if there is no staff interest in sustainability in construction work and building design, then this will not be included in the curriculum to any great extent.

The fact that the professional body is ranked quite highly as a stakeholder, does give some reassurance but as has already been identified the CIOB educational framework is open to interpretation and programmes can be accredited with very little of the curriculum dedicated to sustainability issues. Further reassurance is found in the fact that the 2007 version of the framework has a specific learning outcome relating to sustainability, but it will only be by 2012, that all programmes will be mapped against this in the UK. The involvement of industry in curriculum design is often cited as good practice, but this was ranked as relatively low in the UK. This may not be a major problem though because industry is heavily consulted when the educational framework is revised and therefore industrial input can be derived from mapping against the framework. In addition there is always a member of the accreditation panel who is from industry.

Although the AIB do not have a framework as such, there are certain things that are expected in the curriculum that are checked when they do accreditation visits and this checking is undertaken by academic accreditation panels with some input from industry. This could account for the greater involvement in curriculum development by industry in Australia because they do not have a framework that has been developed with significant input from industry.

There were some interesting comments made in relation to these statements, some of which gave reassurance and some which did not.

Answering the questions about whether curriculum development was learning outcomes driven or input driven caused some consternation because all the programme leaders knew that the expected learning outcomes model is the one that they should be using, but reality dictated that they could not go purely down this route because they have to work in a team of people who have very strong interests. There is also a resources issues, and the reality is that universities cannot employ and/or dismiss staff to satisfy radical changes in the curriculum.

In the UK, again there was some consternation when discussing industry influence. The programme leaders knew that the right answer was to say yes, but in reality this did not happen for a number of reasons. Lack of industry willingness to get involved was one reason why they were not consulted more, but the main reason was that the programme leaders felt that industry see construction management degree programmes as training programmes and as such want more skills included rather than increased and wide ranging knowledge. As one stated:

'A construction management degree is simply a vocational degree, it has a theme but it is still a degree programme. It is not a training programme'

5.3.2.8 Programme leaders' perceptions of industry approaches to sustainable design and construction

Tables 5.16 and 5.17 show the results of the discussions that were asked to ascertain the programme leader's perceptions of industry approaches to sustainable construction and design and whether sustainability is an issue where there will be more emphasis in the future. A number of statements were read out and programme leaders were asked if they strongly agreed, agreed, were neutral, disagreed or strongly disagreed. The responses are also shown in the tables.

UK Responses	I1	I2	I3	I4	I5	I6	I7	I8	mode
Sustainable construction is just a fad hence it will go out of fashion	DS	D	D	D	DS	DS	D	D	D
Utilising sustainable construction techniques is not something that industry is interested so we don't need to worry about it (general consensus is that industry is not worried about it but academia needs to be)	D	SD	D	D	D	D	D	D	D
The main reason industry doesn't green itself is because it will cost them money	SA	A	A	A	D	N	SD	D	A
In future more clients will be asking questions about the environmental performance of contractors	A	A	A	A	A	A	A	A	A
Sustainable and environmental issues are of vital importance so it is vital that students know about these issues	SA	A	A	A	SA	A	SA	A	A
Sustainable construction is simply good management	D	D	A	A	A	A	D	D	A=D

Table 5.16 Responses to industry perception questions and modes(UK)

Australia Responses	I1	I2	I3	I4	I5	I6	I7	I8	mode
Sustainable construction is just a fad hence it will go out of fashion	SD	D	D	D	SD	SD	SD	D	SD=D
Utilising sustainable construction techniques is not something that industry is interested so we don't need to worry about it (general concensus is that industry is not worried about it but academia needs to be)	D	D	D	D	D	N	D	D	D
The main reason industry doesn't green itself is because it will cost them money	D	D	D	D	N	A	SA	A	D
In future more clients will be asking questions about the environmental performance of contractors	A	A	A	A	A	A	SA	A	A
Sustainable and environmental issues are of vital importance so it is vital that students know about these issues	A	D	A	SA	SA	SA	SA	A	SA
Sustainable construction is simply good management	D	D	A	SD	D	D	D	D	D

Table 5.17 Responses to industry perception questions and modes (Australia)

Tables 5.18 and 5.19 give the results converted into numerical data and calculated means.

UK Responses	I1	I2	I3	I4	I5	I6	I7	I8	Mean
Sustainable construction is just a fad hence it will go out of fashion	1	2	2	2	1	1	2	2	13 SD-D
Utilising sustainable construction techniques is not something that industry is interested so we don't need to worry about it	2	1	2	2	2	2	2	2	15 SD-D
The main reason industry doesn't green itself is because it will cost them money	5	4	4	4	2	3	1	2	25 N
In future more clients will be asking questions about the environmental performance of contractors	4	4	4	4	4	4	4	4	32 A
Sustainable and environmental issues are of vital importance so it is vital that students know about these issues	5	4	4	4	5	4	5	4	35 SA-A
Sustainable construction is simply good management	2	2	4	4	4	4	2	2	24 N

Table 5.18 Responses to industry perception questions- mean calculations (UK)

Australia Responses	I1	I2	I3	I4	I5	I6	I7	I8	Mean
Sustainable construction is just a fad hence it will go out of fashion	1	2	2	2	1	1	1	2	12 SD-D
Utilising sustainable construction techniques is not something that industry is interested so we don't need to worry about it.	2	2	2	2	2	1	2	2	15 SD-D
The main reason industry doesn't green itself is because it will cost them money (Main reason is that they don't know how to- link to education)	2	2	2	2	1	4	5	2	20 D-N
In future more clients will be asking questions about the environmental performance of contractors	4	4	4	4	4	4	5	4	33 A
Sustainable and environmental issues are of vital importance so it is vital that students know about these issues	4	2	4	5	5	5	5	4	34 SA-A
Sustainable construction is simply good management (Australians thought there was more to it)	2	2	4	1	2	2	2	2	25 SD-D

Table 5.19 Responses to industry perception questions- mean calculations (Australia)

There was mainly strong disagreement that sustainability is a fad and it will go out of fashion and we will move on to another topic of interest in a few years. One UK interviewee summed up the general feeling:

'There is no going back from the global requirements to be able to live sustainably'

and one of the Australian interviewees went further in stating that:

'It's been ignored for long enough and it's now got to the point where we can't afford to ignore it anymore'

The responses to the statement regarding how important industry views the issues of sustainability, and whether academia needs to take it seriously was answered in two parts. General consensus in both countries was that industry is not taking it seriously, but that academia needs to be to educate the professionals of the future that could make a difference.

The statement that caused most varied responses was related to whether industry does not green itself more readily because it will cost them money. In the UK sample the modal response was to agree with this, but there were three respondents that disagreed. Again in the Australian data, the modal response was to disagree with the statement, but there were two who agreed and one that strongly agreed. The variety of responses in the UK data meant that the mean score equates to a neutral response and in the Australian data the mean calculated out as a borderline disagree/neutral. However this neutrality does not correctly describe the actual feedback from the interviewees and rather than using the quantitative approach to discuss this statement, a qualitative one will be used to explain the differing responses.

The reasons for agreeing with the statement in the UK were:

'I think the industry mistakenly thinks it will cost it money, but that is what the industry always thinks about change I don't want it, it will cost me money. It could actually earn them a lot of money. I am afraid it will be client driven rather than industry driven'

'I would agree with that, it will need legislation to force clients to ask questions regarding sustainability'

'the main reason that it doesn't green itself is because of cost, just the same as the main reason it doesn't take the problem that seriously. Cost is always a problem for clients so in the future if legislation changes then everybody is going to be forced to tow the sustainability line including clients'

'I think it is because they can't see the benefit of it. If they can see a financial benefit then they will do it'

'Agree, however maybe in the future more clients will be asking questions about the environmental performance of contractors'

The reasons for disagreeing with the statement were:

'I think the reason that construction does not 'green' itself is lack of awareness, it's not intentionally ignoring it; it's simply lack of awareness'

'What you need is a policy, so I am pretty neutral because I am going along the line that you need to be able to respond to having a policy, but I don't think the policy in itself will do any good so I am neutral'

The reasons for agreeing with the statement in Australia were:

'There's definitely a cost thing, you know that margins are low and anything that costs money is going to be reviewed. But I think the influence that government in particular is having on these organisations may insist that they need to demonstrate that they have these kind of environmental plans. Then perhaps they might realise that they are actually getting some benefits out of doing it that might improve the attitude of them'.

'If they could see the benefits financially then they would spend the money upfront to implement sustainability systems. If you can't see the benefits you will not spend that money'

The reasons for disagreeing with the statement were:

'I don't think it's the industry I think it's the demands of their clients. Their clients have not seen the benefits and don't want to pay extra'

'It is clients that can't see a benefit on the bottom line, if they could see a financial benefit then they would do it'.

'Disagree, I don't think that's it. I don't think they know how to do it'

The results obtained using a quantitative approach, showed a difference in means and modes in both the UK and Australian data. However when the individual statements are reviewed the attitudes and perceptions in both countries are basically the same and can be summarised as the main causes of agreement to the statement are that the industry does believe to build 'green' will cost more and therefore they are not willing to implement sustainable systems. Clients need to demand that contractors prove that they are designing and constructing buildings with sustainability in mind and if all contractors tender on the same basis it will not cost them money. There was agreement that to make clients demand this, government policy needs to be introduced.
Disagreement with the statement came from the opinion that industry just does not know how to green itself.

There was total agreement in both countries that clients will be asking more questions about the environmental performance of contractors, the only concern being that smaller clients may not be aware enough of the potential impacts on the environment from construction works and buildings to know what questions to ask. Therefore government policy would be required. There was similar full agreement that sustainable and environmental issues are of vital importance and that students know about these issues.

The Australian respondents disagreed with the statement that sustainable construction is simply good management. They believed it is much more than that and even if you are a good construction manager, in order to be a good sustainable construction manager you need to know the impact of construction work on the environment, how you can prevent more damage from a technical perspective and have the ethical stance to actually stand up and promote sustainable construction management as the new way of working.

In the UK the responses were diverse and four respondents agreed and four disagreed. When reviewing the responses the main school of thought seemed to be that it should be just good management but actually you do need more focussed and specific knowledge which concurs with the Australian findings.

5.3.2.9 Confirmation of responses and future developments

The final set of questions was designed to finalise the interviews, try to provide some clarification to previous questions and to assess future planned developments.

In the UK and Australia the most emphasis on sustainability comes in the technology and building services subjects. There is also a significant amount incorporated in the management modules, a couple of universities stated that they had bespoke environmentally focussed modules and there seemed to be a consensus that environmental issues were taking more precedence in project modules.

Integrated and interdisciplinary projects were viewed by the majority as the best tools for the promotion of environmental literacy, but these need to be supported by the use of a broader approach of lectures, tutorials, laboratory work that can culminate a project

When the UK programme leaders were asked what predicted future curriculum changes they thought would occur, the responses were very negative and related directly to the problems of student under recruitment at the time of the interviews. However there was an underlying theme to a number of responses. There was a view that the curriculum now is not a curriculum in terms of knowledge which it has always been, but a series of syllabuses that link together and are supplemented by skill and competency development. There is too much knowledge to fit into the tight modular systems now employed in the UK, so the emphasis needs to be to ensure that students are given the maximum possible knowledge base, it should be acknowledged that this is not everything they need to know, universities should assist them in developing the skills of researching to find out information, reflecting on their own knowledge and skills levels and planning how they can improve in these areas. The implication of this approach is that universities need to make sure they make people life long earners and that they have give them their skills and competences along with a core of the curricula so that they can take off and go further. The other change that was seen as necessary in the UK was to revert back to the more traditional construction management programme that includes very generic construction subjects but without a specialism. The programme leaders appeared to feel that specialism should be left to organisations to train employees to the job that they want as opposed to universities who should concentrate on students learning and knowledge expansion rather than training to do a specific job.

In Australia, the comments were much more positive, possibly due to the buoyant student numbers and were very different from the UK responses. The programme leaders were focussing their ideas on developing more generic project management modules because they believed that if you teach students the generic information they can then apply this to specific situations. In this mind set, the Australia programme leaders are possibly a number of years behind the UK programme leaders because it is this approach that is adopted now in the UK and programme leaders are less than satisfied with this.

5.4 Conclusions of Phase 2

5.4.1 General findings

The analysis of the data clarified and verified some of the findings of the literature review and phase 1 data analysis, however some findings were also queried. One of the main overall findings was that the literature reviewed has been written from theoretical and halcyon perspectives. In reality, academics know what good practice is but cannot always implement this due to a number of barriers and resource constraints. The need for the research has been validated with the evaluation of the findings of phase 2.

It has been verified that programme leaders believe that industry needs to change and become more sustainably aware and active. There is agreement, if tentative, that the graduates of construction management programmes are the people who can influence industry by intergenerational attitudinal changes. It has been acknowledged that the construction industry is slow to develop innovative practices and respond quickly to change, but that graduates of sustainably focused degree programmes can be the catalysts for change. It has also been generally agreed by programme leaders that student attitudes change over time with increased knowledge of sustainable design and construction.

The most powerful stakeholders in curriculum design and therefore curriculum change are generally agreed to be the academic teaching staff of a department, supported by professional body guidance that is influenced by industry and therefore to give guidance on curriculum design to programme leaders should be useful.

However it has been identified that this may not be enough to make the substantial changes to industry practices that are needed to reduce environmental damage caused by construction work and buildings. There is strong support for the idea that in order to make major changes then clients need to be advised as to how they can reduce environmental damage when procuring building works, and therefore they have to become knowledgeable clients. There are two main methods of achieving this, one is that graduates become client advisors and stress the importance of building green instead of building cheap, the other way would be for the government to introduce legislation to make clients act more environmentally responsibly.

5.4.2 Comparison of UK and Australian data

The main differences between the data gathered in the UK and Australia are:
In the UK interdisciplinary approaches to teaching and learning are more prevalent, but this is due to the lower demand for the programme at the time of the interviews. Interdisciplinary approaches to teaching have been adopted in the UK mainly to ensure the viability of programmes by more efficient delivery through multi group teaching.

In Australia there appears to be more integration of environmental issues, especially design, in the programmes and the reason for this is that constriction management students are taught regularly with Architecture students which is rare in the UK. The Australian respondents did not feel that student attitudes changed much during the study of their programme, but this is explained by the fact that most Australians are better environmentally educated at school level which is a consequence of the Australian government intervention in the state education system which is due to the effects that Australia is witnessing due to climate change and reduction in the ozone layer. The Australian students would appear to enter university more knowledgeable on global environmental issues and have positive attitudes to the potential for change in the construction and property industries.

The UK students appear to be less knowledgeable on entry to university, and therefore need to be taught about global issues and then focus on sustainability in the context of their studies. As their knowledge increases their attitudes change.

The Australian programme leaders claimed that there was more industrial input into their curricula designs than in the UK. However this can be countered by the fact that industry in the UK has a lot of input into the CIOB educational framework. Therefore in the UK, for programmes mapped against the framework which all the programmes are, there is inadvertently a good deal of industry input. The only other aspect of the study where there was a difference of opinion is the fact that in Australia, all the respondents believed that sustainable construction is not just good management, but requires significant additional technical knowledge and ethical behaviour traits. In the UK the responses were divided with half the respondents believing that it is just good management, and half believing that there is more to it.

A further finding from the analysis of the Australian data was that there is no significant difference in the curricula of the different universities and the curriculum is not, as was envisaged, adapted to suite different climates.

On every other aspect of the study the combined responses were very similar, which was surprising given the authors research hypothesis that was developed for the international comparison was:

'In Australia there will be a much greater focus on environmental issues and sustainability in construction management programmes because damage to the environment is much more evident there than in the UK'

The primary data collection and subsequent analysis has disproved this hypothesis and there are no elements of good practice that are substantially different in curriculum design in Australia to those employed in the UK.

The findings of phase 1 and phase 2 were used as the basis for the development of a model that could be used to inform curriculum design to enhance the literacy in sustainability of construction management students.

6.0 Development and Implementation of the Curriculum Model

6.1 Principles of curriculum design

This section distils the findings of the data analysis and addresses the main aim of the research project that is to produce a set of well-developed principles that can be used to inform curriculum modelling for construction management undergraduate programmes that will enhance students' literacy of sustainability in the context of construction work and buildings. Barriers to potential implementation of these principles have also been identified and possible solutions suggested.

Construction and Property programmes that are accredited by the CIOB have to adhere to the educational framework and the principles set out below in table 6.1 enable the framework to be mapped against, allow for individual universities to be able to demonstrate a specialism of their programme and should promote environmental literacy.

Principle 1 **The curriculum should be designed using Expected Learning Outcomes as the starting point.**
Expected Learning Outcomes for the programme should be determined followed by learning outcomes for each level. Learning outcomes for each module should then be devised.
Barriers Whilst most academics would agree that this principle is aspirational, in reality there will usually be an element of the curriculum that is input driven. Universities have a body of academic staff with specialisms and these specialisms can influence the curriculum quite strongly. This in itself is not a major problem if kept in check, because the CIOB supports the idea of different programmes having different focuses as long as the key learning outcomes are covered. However from the perspective of increasing environmental content, if there is too much specialism there will be no room left in the curriculum for this to occur.

Principle 2 The curriculum should be holistic
The curriculum should not be designed as a series of discreet modules. They should be complementary.
Barriers Most universities work on a modular, semesterised system and this encourages the use of discreet modules that build up a curriculum. In addition to this the CIOB framework is presented in a way that encourages this. The subjects required, especially in levels 1 and 2, are quite different in content and again this can encourage discretion. However a solution to this is to use modules that pull together subjects, for example project modules.

Principle 3 **Environmental aspects should be delivered via the curriculum in both integrated and fragmented ways.**
There should be reference to sustainability in the majority of modules in the correct context, and in addition there should be bespoke modules that address this issue.
Barriers Space in a credit based curriculum is limited and in addition the CIOB framework is very detailed. It may be difficult to 'fit' everything in. It has been identified that students need to know about global environmental issues and about sustainably in the context of other subjects. They need to know a good deal about sustainable construction practice and design. However this requires the teaching staff to be knowledgeable and motivated enough to deliver a curriculum like this, and there is evidence that there is a lack of knowledge about the subjects and a lack of motivation to develop this knowledge.

Principle 4 **The curriculum should be designed around themes**
A series of themes should be identified and these themes should develop though the curriculum. As stated in the educational framework, level 1 should set about establishing principles in the correct context, level 2 should enable analysis and application of principles and level 3 should enable synthesis and evaluation.
Barriers The themes identified may be too strongly linked to staff specialisms.

Principle 5 **The curriculum should be designed to enable as much interdisciplinary learning as possible.**
Most university construction and property departments will deliver a wide range of programmes in these fields. Students should be given the opportunity to work with students from other programmes so that they can establish where and how their particular discipline is placed. This will assist in the students being able to contextualise their chosen discipline and illustrate how work in construction and property is a team game that requires all parties to determine the solution to problems. Guthrie(2007) states that interdisciplinary education can be achieved by the students having lectures from practitioners in other disciplines and by the use of case studies.
Barriers Most universities take this approach by group teaching where all disciplines are taught together in common modules, but there is little evidence of interdisciplinary learning. The relevance of the subject being taught to their discipline may not be immediately obvious to them and there can also be problems with cohort identity.

Principle 6 **There should be opportunities to allow for the use of real life case studies in the curriculum to enhance the learning experience.**
Students may only see the relevance of teaching and assessment if it is related to real situations.
Barriers It can be difficult to obtain case studies that are not too complex for use as student projects.

Principle 7 **There needs to be a mechanism embedded in the curriculum that will enable the students to reflect on preconceived beliefs and undertake a critical analysis of their attitudes to the environment.**
This can be achieved via PDP that is required by the QAA in all undergraduate programmes, but it would need to be more focussed o environmental knowledge attainment and its impact on students' attitudes than it is generally.
Barriers In order to do this, a great deal of academic staff time is required. Therefore more innovative tools need to be developed in order to achieve this.

Principle 8 **There needs to be a mechanism embedded in the curriculum that will enable the students to develop and practice research skills**
This is usually achieved in an individual, large research project such as a dissertation
Barriers A great deal of academic staff time is required to ensure suitable supervisions can be provided for every student. Student lack of exposure to research methodologies early in their studies can often lead to poor quality projects.

Principle 9 **The staff resource needs to be encouraged and developed to deliver a curriculum based on principles 1-8**
The writing of a curriculum may be undertaken by one person only, but the delivery will be undertaken by a group. 'Buy in' of staff is therefore required.
Barriers This will require a great deal of meetings and co-ordination that may be difficult to achieve. Staff development related to how sustainability needs to be included would have to be offered.

Table 6.1 Curriculum design principles

6.2 Development of a model for curriculum design to promote sustainable literacy

Using the principles developed in 6.1, Huack's (1998a) list of essential elements of construction curricula, the schema suggested by Moon (1999) to guide reflective activity in professional development towards improvement of professional practice, Graham's (2000) model of teaching for learner empowerment, the recommendations for sustainable construction as set out in the draft strategy for sustainable construction (DfBEE, 2007), and the findings that research and PDP are required in the construction curriculum, a model was devised for curriculum design that could develop sustainability literacy in students. The model is entitled 'The Future Paradigm for Sustainable Construction Curriculum Design' and shows graphically the principles required for curriculum design and at what phase of curriculum development each principle needs to be considered.

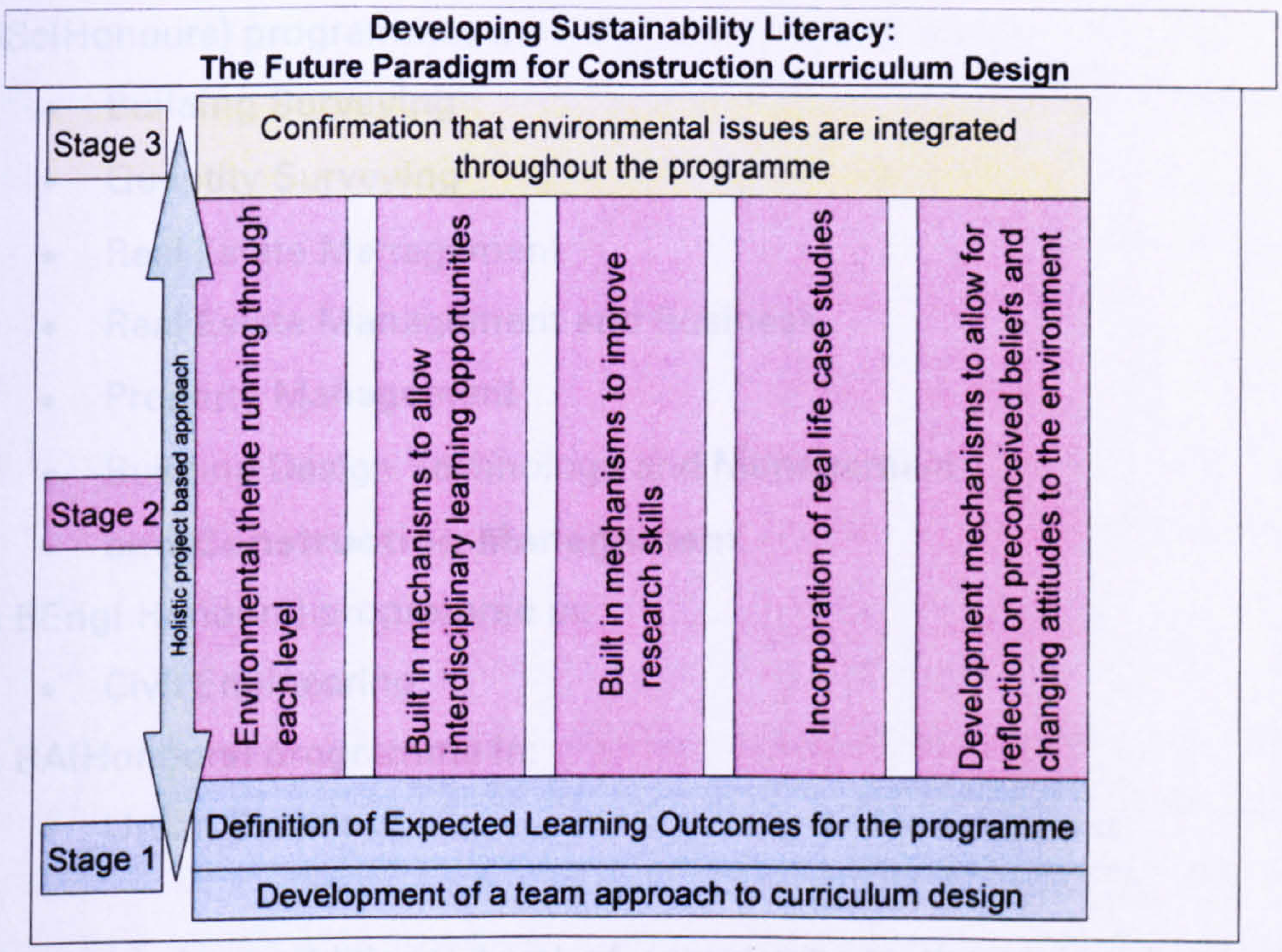


Figure 6.1 The Future Paradigm for Sustainable Construction Curriculum Design

6.3 Revision of BSc (Hons) Construction Management-Overview

The work undertaken for this project is very much applied research. The aim was to develop a supplementary methodology for curriculum design that could improve literacy of specific (environmental) subjects in vocational degree curricula. The initial study focussed on determining what knowledge was required of sustainability and to what level, the stance that professional bodies have taken and approaches to curriculum design that have been advocated by earlier writers. The phase 1 data collection verified the need for the work and highlighted gaps in knowledge that resulted in the need for further data collection in phase 2. The phase 2 analysis of data enabled the model to be developed, but to apply the research, a case study is required.

In order to implement the model to influence curriculum design, a total review of the Construction Management programme at LJMU was required and this is termed the 'case study'. Due to the issues relating to interdisciplinary approaches to teaching and learning, a decision was made to review all the undergraduate programmes that are delivered in the School of the Built Environment at Liverpool John Moores University. These programmes are:

BSc(Honours) programmes in:

- Building Surveying
- Quantity Surveying
- Real Estate Management
- Real Estate Management and Business
- Property Management
- Building Design Technology and Management
- **and Construction Management**

A BEng(Honours) programme in:

- Civil Engineering

A BA(Honours) programme in:

- Urban Planning

This added an additional level of complexity to the review because so many programmes are involved and are accredited by different professional bodies as shown below in table 6.2.

BSc(Honours) programmes in: Building Surveying	Royal Institution of Chartered Surveyors
Quantity Surveying	Royal Institution of Chartered Surveyors
Real Estate Management	Royal Institution of Chartered Surveyors
Real Estate Management and Business	Royal Institution of Chartered Surveyors
Building Design Technology and Management	Chartered Institute of Building
Construction Management	Chartered Institute of Building
Property Management	None, but planned to apply for Chartered Institute of Building after first cohort of graduates.
BEng(Honors) programme in: Civil Engineering	Institution of Civil Engineers
BA(Honours) programme in: Urban Planning	Royal Town Planning Institute

Table 6.2 Professional body accreditation of LJMU programmes

The professional bodies have their own requirements for accreditation and these were summarised in table 2.4. Any changes made had to comply with the requirements of the model and the CIOB framework, and any actions that affected other programmes then had to be checked to ensure compliance with the relevant professional body.

6.3.1 Process of redesign

The approach taken to the curriculum redesign was planned using the principles outlined by Walkington (2002) and is very similar to the model developed by Reis and Roth (2007).

Walkington (2002) states that curriculum change presents an ideal for the development of effective higher education curriculum, yet acknowledges that the unique nature of each context, its needs and constraints will lead to an individualisation of the process. Context determines the priority given to various elements but is sufficiently flexible to cater for contextual variants, and based on sound educational principles to enhance effective outcomes.

Principles of curriculum change, guide the process and the change should be seen as a journey, it is non linear and loaded with uncertainty. Every person involved is a change agent with a variety of contributions and these contributions should all be treated as valuable (Fullan, 1993). Curriculum changes require contextual change for them to be accepted and sustained (Cornbleth, 1990). Top down and bottom up strategies of organisation are required and evaluation is very much a necessary component of change.

Walkington explains the process via a number of stages. These are:

Stage 1 Background and setting for the change.

Key questions asked at this stage are why curriculum change is needed and what contextual information is required to inform the nature and process of change.

Stage 2 Refining the nature of the change (academically and managerially)

This stage involves dissemination of stage 1 ideas to those who will be involved in the change and for clarification and refinement.

Stage 3 Design and Development of the curriculum

This stage involves the development of specific curriculum to be implemented. The success of this stage is based on the correct decisions having been made in the previous stage and the degree of collaboration and willingness of team members to compromise.

Stage 4 Implementation and evaluation

As with all major changes that are made in curriculum design, it may not be perfect the first time it is implemented. Logistical issues such as initial timetabling may be complex and problems with timetabling may only become apparent when students start to study the programmes, but these problems can be rectified relatively easily in most cases. Academic problems may take longer to appear and can be more difficult to solve quickly than logistical problems, and any evaluation of the success of a curriculum change can only be undertaken fully after the programme has been undertaken fully by a cohort of students. Even that may not be fully informative and it may be necessary to monitor success of the curriculum a number of years after a cohort has graduated.

Figure 6.2 illustrates how these stages relate to the future paradigm for sustainable construction curriculum design model.

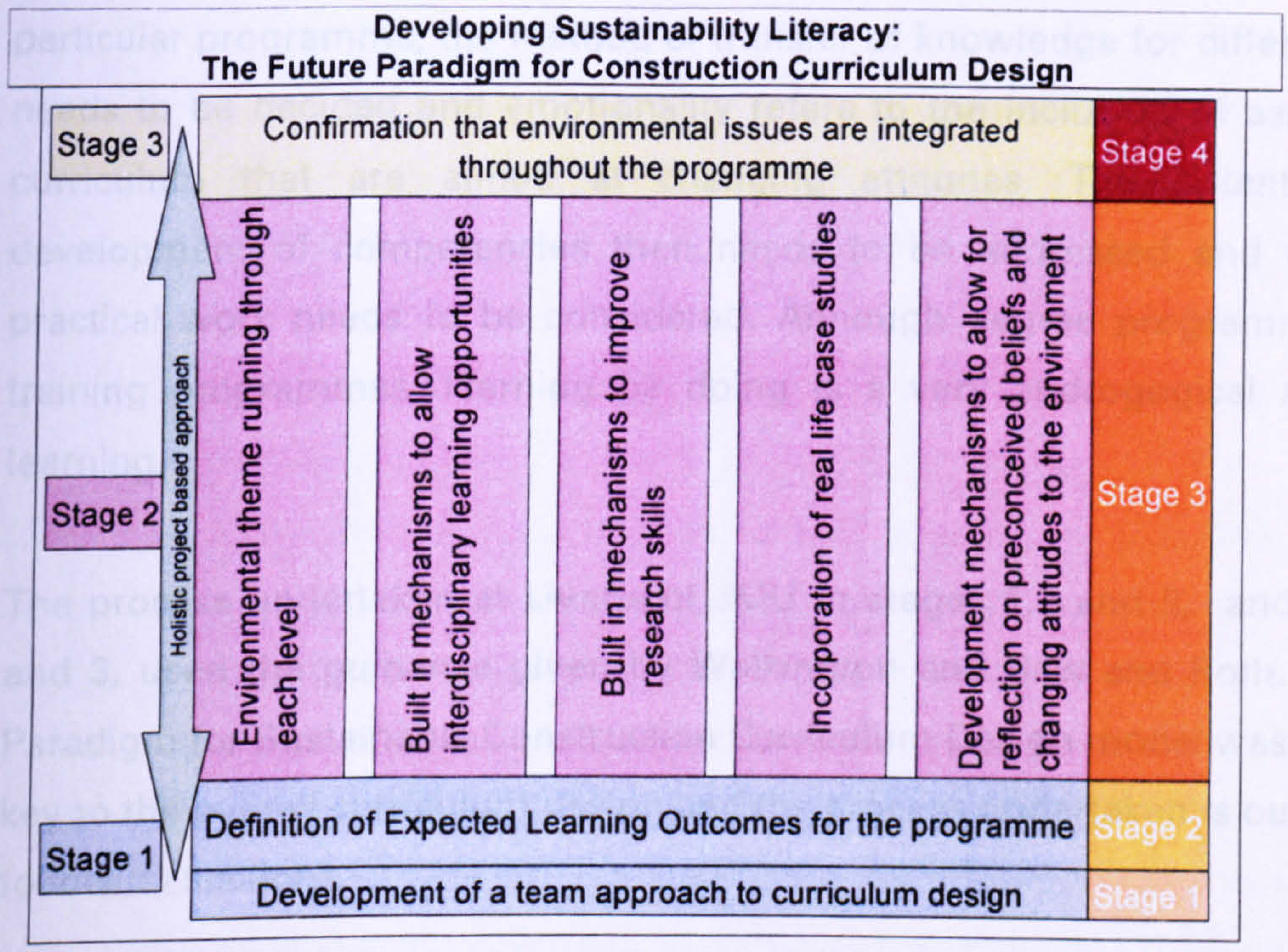


Figure 6.2 Relationship of Walkington's (2002) 4 stages of curriculum change to the future paradigm for sustainable construction curriculum design model.

The model for curriculum developed by Reis and Roth (2007) is based around two premises which are why do we do what we do and how we do what we do. This is shown diagrammatically in figure 6.3

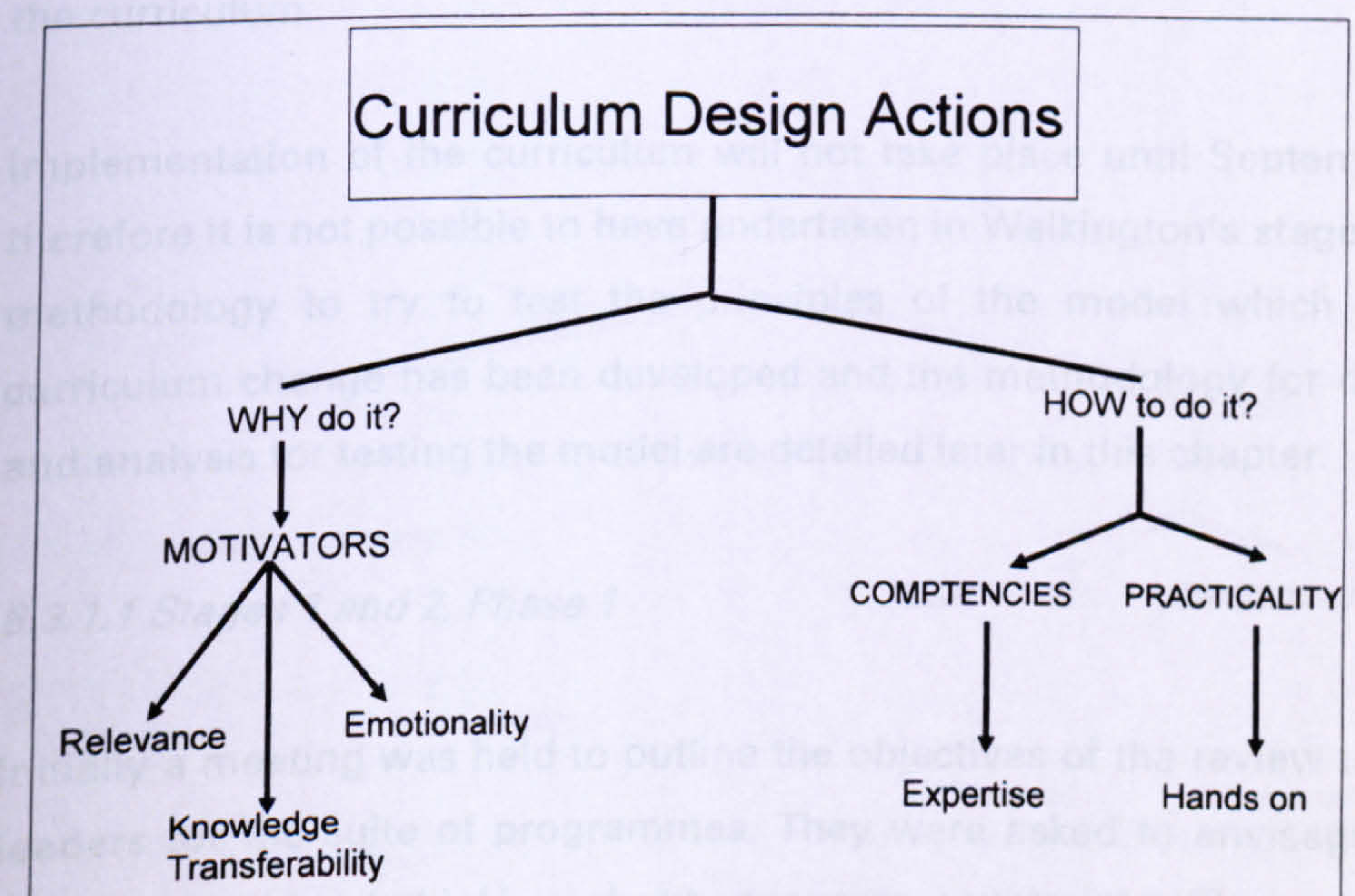


Figure 6.3 Curriculum Design Actions. Source Reis and Roth (2007)

Initially the motivators need to be established and these are described in three ways. The term relevance relates to whether particular subjects are relevant to a particular programme, the method of transfer of knowledge for different subjects needs to be decided and emotionality refers to the inclusion of aspects of the curriculum that are aimed at changing attitudes. The potential for the development of competencies then needs to be addressed and the level of practical work needs to be considered. Although degree programmes are not training programmes, learning by doing is a very androgogical approach to learning.

The process undertaken at Liverpool JMU in stages 1,2 and 3, and phases 1,2 and 3, used the guidance given by Walkington and Reis and Roth. The Future Paradigm for Sustainable Construction Curriculum Design model was used as the key to the overall curriculum design and the process undertaken is outlined in the following sections.

A plan for the reform of the Construction Management programme was developed and this included proposals for teaching approaches, learning methodologies and assessment techniques. The approach to assessment for interdisciplinary environmental education courses recommended by Tal (2005) is multiple mode, and this recommendation was also used in the development of the curriculum.

Implementation of the curriculum will not take place until September 2008 and therefore it is not possible to have undertaken in Walkington's stage 4. However a methodology to try to test the principles of the model which informed the curriculum change has been developed and the methodology for data collection and analysis for testing the model are detailed later in this chapter.

6.3.1.1 Stages 1 and 2, Phase 1

Initially a meeting was held to outline the objectives of the review to programme leaders for the suite of programmes. They were asked to envisage programme structures without thinking about resources constraints. The questions posed were 'If resources were unlimited what would you want to be in your programme(s)?' and 'What do you think graduates of your programme(s) should know and be able to do? The ideas of what were needed derived from using the Reis and Roth model.

A series of brainstorming sessions led to a series of programme learning outcomes to be developed and ideas for sharing of modules by different programmes were formed.

6.3.1.2 Stage 3, Phase 2

After the programme learning outcomes had been developed, the programme leaders were asked to set up subject group meetings to refine their ideas and decide on programme level learning outcomes and decide on a suite of modules that would achieve these outcomes. This was undertaken and the programme leaders presented their subject group ideas to a meeting of all the programme leaders. Only the construction management programme leader in conjunction with the author were required to comply with the phase 2 recommendations because the model was developed for construction management programme curriculum design. However the principles were also adopted significantly by the Civil Engineering and Building Surveying teams and in part by the Quantity Surveying, Urban Planning and Real Estate Management teams. As has been stated previously, curriculum design needs to be a team effort and as such the author respected the decision not to adopt the use of the model in its entirety for the other programmes. At this point the titles of modules were decided and which modules would form part of which programmes were agreed. Some standard rules for assessment were also decided at this point that would ensure that students on each of the programmes would be assessed equitably. Every member of academic staff in the School was then tasked with producing individual module proformas armed with the knowledge of what the programme leader wanted to achieve.

6.3.1.3 Stage 4, Phase 3

After production of the module proformas they were checked by the programme leaders to ensure that the level and programme learning outcomes would be achieved using the mix of modules and the recommended assessment components. The author checked that for construction management the environmental theme was in place and that sustainable construction and design principles were included to the correct levels and in the correct modules. A final check was then made to ensure that the programme learning outcomes mapped against the CIOB educational framework. The programme was validated in December 2007 and will commence to be delivered in its new form in September 2008.

As has been stated, stage 4 cannot be fully undertaken until the programme has been implemented but the measures recommended by Walkington (2002) will be utilised to undertake this stage fully using:

- Student performance measures (exam board reports)
- Student perceptions (student module and programme feedback questionnaires)
- Teaching staff perceptions (annual and intermediate section meetings)
- Administrative issues (reports from administrative staff as to how easy the programme is to timetable and collate exam board information)
- Academic comments (from external examiners)
- Industrial and employer perceptions (industrial liaison group meetings)

6.3.2 The Product

The programme structure developed using the models described in 6.1.1 is shown in figure 6.4. In addition the curriculum has been mapped to ensure that the recommendations proposed in the Draft Strategy for Sustainable Construction: A consultation paper (DfBERR, 2007), which sets out four priority areas for action for a sustainable construction industry are addressed. The priority areas are:

1. Sustainable consumption and production

- An industry which will design better products and services reducing the environmental impacts fro the use of energy, resources and hazardous substances.
- An industry which will reduce, and ultimately eliminate waste in construction through improved design, procurement, and greater re-use and recycling of resources.
- An industry where there will be re-use of existing built assets and the construction of new, long lasting, energy conscious and future proof(adaptable and flexible) buildings and structures which are easy to maintain, operate and deconstruct

2. Climate change and energy

- An industry which minimises carbon emissions during construction
- An industry which builds buildings which have a lower carbon footprint in use, leading to the construction of zero carbon buildings
- An industry which builds innovative solutions to climate change challenges for the future.

3. Natural Resources and enhancing the environment

- An industry which facilitates conservation of water resources in new construction and refurbishment projects.
- An industry which recognises that Green Infrastructure plays a valuable role in delivering a range of social, environmental and economic benefits to society.
- An industry which is proactive in creating, managing and enhancing wildlife habitats and natural landscapes.

4. Creating sustainable communities

- An industry which employs and nurtures a committed, skilled and adaptable workforce working in an environment of zero accidents and incidents with appropriate arrangement for education and training, employment, health and safety.

This strategy although still draft, has been produced at government level with input from industry. Therefore it is assumed that if all of the above is incorporated in the curriculum, then it will address the needs of industry.

CONSTRUCTION MANAGEMENT

<table>
<tr><td>Semester 1</td><td rowspan="2">Construction Technology and Services 1 BUEUG1001</td><td>Properties of Materials BUEUG1010</td><td rowspan="2">Site Surveying and Measurement BUEUG1004
CAD BUEUG1006</td><td>Construction and Property Environment BUEUG1003</td><td>Applied BE Maths BUEUG1018</td><td rowspan="2">Industrial Project 1 BUEUG1005</td></tr>
<tr><td>Semester 2</td><td>Environmental Science BUEUG1015</td><td>Law BUEUG1002</td><td></td></tr>
<tr><td>Semester 3</td><td rowspan="2">Construction Technology and Services 2 BUEUG2001</td><td>Environmental Studies BUEUG2008</td><td rowspan="2">Advanced Site Surveying BUEUG2021</td><td>SCM and Procurement BUEUG2004</td><td>Economics of Development BUEUG2007</td><td rowspan="2">Industrial Project 2 BUEUG2009</td></tr>
<tr><td>Semester 4</td><td>Construction Site Management BUEUG2015</td><td>Construction Law BUEUG2013</td><td>Operations Research & Statistics BUEUG2002</td></tr>
<tr><td>Semester 5</td><td rowspan="2">Construction Technology Refurbishment Project BUEUG3013</td><td>Construction Site Management BUEUG3002</td><td>Risk Management Strategy BUEUG3017</td><td>Construction Contract Practice BUEUG3004</td><td rowspan="2">Individual Project BUEUG3001</td><td rowspan="2">Professional Project BUEUG3008</td></tr>
<tr><td>Semester 6</td><td>Environmental Management BUEUG3007</td><td>International Construction Studies BUEUG3018</td><td>Professional & Business Practice BUEUG3033</td></tr>
<tr><td></td><td>Technology</td><td>Science & Environment</td><td>Specialism</td><td>Law & Management</td><td>Research</td><td>Application</td></tr>
</table>

Figure 6.4 Construction Management course structure

6.3.2.1 Application of findings to the design of the construction management curriculum

The Future Paradigm for Sustainable Construction Curriculum Design was developed using the principles for curriculum design generated from the findings of phase 2, Graham's (2000) model of teaching for learner empowerment, Huack's (1998a) list of essential elements of construction curricula, the recommendations for sustainable construction as set out in the draft strategy for sustainable construction (DfBEE, 2007) and the findings that research and PDP are required in the construction curriculum.

Table 6.3 outlines how the principles of the model and other findings have been applied in the development of the construction management curriculum.

Principle 1 **The curriculum should be designed using Expected Learning Outcomes as the starting point.**
Expected Learning Outcomes for the programme should be determined followed by learning outcomes for each level. Learning outcomes for each module should then be devised.
Application The Learning Outcomes required for the programme have been taken from the CIOB educational framework and an additional outcome for the programme has been developed to reflect the specialisms of the LJMU team. The expected learning outcome for the environmental theme is: *'After completion of the programme, students will have a knowledge of sustainable construction and design and skills to enable solutions for environmental problems to be developed'*

Principle 2 The curriculum should be holistic
The curriculum should not be designed as a series of discreet modules. They should be complementary.
Application LJMU utilises a modular system where a combination of 12 and 24 credit modules are developed to provide 120 credits at each level of an undergraduate programme(360 credits). This, and the fact that the CIOB educational framework is written in a format that encourages discrete units of teaching can discourage a holistic approach. However the use of project modules to allow the bringing together and application of knowledge and skills in one module goes some way to alleviate this. The Industrial Projects 1 and 2 and the Professional Project at level 3 will achieve the aim of this principle.

Principle 3 **Environmental aspects should be delivered via the curriculum in both integrated and fragmented ways.**
There should be reference to sustainability in the majority of modules in the correct context, and in addition there should be bespoke modules that address this issue.
Application Integration of sustainability is facilitated in the Construction Technology and Services 1 and 2, the Construction Technology Refurbishment Project, the Properties of Materials and levels 2 and 3 Construction Site Management modules. It is also introduced as a concept in level 1 in the Construction and Property Environment module, and is expanded to a global level in the International Construction Studies module. Ethical issues relating to sustainability are covered in the Professional and Business Practice module. Application of all knowledge attained in these modules is applied in the Industrial Projects 1 and 2 and the Professional Project at level 3. There is also an environmental theme that runs through the programme which is where the fragmentation occurs and will enable a framework to be developed so that the specific knowledge in each of the modules can be easily contextualised. These modules are Environmental Science, Environmental Studies and Environmental Management. Therefore 36 credits of the programme are dedicated to environmental issues generally, and sustainable construction management and design are integrated in 132 credits of the programme which is just over half the credits of the programme. All the requirements for a construction management programme are still included so this does

not detract away from the prescribed CIOB learning outcomes.

<u>Principle 4</u> **The curriculum should be designed around themes**
A series of themes should be identified and these themes should develop though the curriculum. As stated in the educational framework, level 1 should set about establishing principles in the correct context, level 2 should enable analysis and application of principles and level 3 should enable synthesis and evaluation.
<u>Application</u> The themes that were identified are Technology, Science and Environment, Law and Management, Research, Application and Specialism. The Specialism modules are those that have developed from staff expertise (Site Surveying and Measurement is required for CIOB accreditation and is therefore a learning outcome) and only account for 48 credits of the programme. Therefore only 13% of the curriculum is input driven, and the other 87% is derived from expected learning outcomes. As has been discussed in the analysis of the phase 2 data, it is virtually impossible for a totally learning outcome approach to be achieved, but in the LJMU model this approach is in the majority.

<u>Principle 5</u> **The curriculum should be designed to enable as much interdisciplinary learning as possible.**
Most university construction and property departments will deliver a wide range of programmes in these fields. Students should be given the opportunity to work with students from other programmes so that they can establish where and how their particular discipline is placed. This will assist in the students being able to contextualise their chosen discipline and illustrate how work in construction and property is a team game that requires all parties to determine the solution to problems. Guthrie(2007) states that interdisciplinary education can be achieved by the students having lectures from practitioners in other disciplines and by the use of case studies.
<u>Application</u> There is a large percentage of this programme where joint teaching with other groups will occur, but this has been dismissed as interdisciplinary learning. The opportunities for interdisciplinary learning occur mainly in the project modules. In levels 1 and 2 the students will work with students from two other programmes and in the final year project with students from seven other programmes. Further opportunities for interdisciplinary learning are not possible because of logistical problems.

<u>Principle 6</u> **There should be opportunities to allow for the use of real life case studies in the curriculum to enhance the learning experience.**
Students may only see the relevance of teaching and assessment if it is related to real situations.
<u>Application</u> All the project modules will be based on real life case studies and industrial support has been gained to supply these case studies and input into the projects. Group project work forms the part of the assessment regime in many of the modules, and again real life case studies will be used to facilitate this work.

<u>Principle 7</u> **There needs to be a mechanism embedded in the curriculum that will enable the students to reflect on preconceived beliefs and undertake a critical analysis of their attitudes to the environment.**
This can be achieved via PDP that is required by the QAA in all undergraduate programmes, but it would need to be more focussed o environmental knowledge attainment and its impact on students attitudes than it is generally.
<u>Application</u> This aspect is included in the project modules and the students will use the university

e-learning portfolio system to undertake this.

Principle 8 **There needs to be a mechanism embedded in the curriculum that will enable the students to develop and practice research skills**
Students sometimes struggle with the concepts of research methodology and referencing because of a lack of exposure to these earlier on in their studies.
Application In level 1 the students will study the construction and property environment module and one of the learning outcomes will be that they have to demonstrate referencing skills. The nature if the assessment will introduce the concepts of undertaking a literature review. In level 2 the operations and statistics module will introduce the students to the concepts of qualitative and quantitative approaches to research and data collection. It will also allow them the opportunity to develop data analysis skills using statistical methods. The Individual Project in level 3 is designed to allow students to practice literature review, data collection, data analysis and referencing skills. As they will have had a chance to undertake all of these aspects in levels 1 and 2, it is hoped that the final projects will be of a higher quality.

Principle 9 **The staff resource needs to be encouraged and developed to deliver a curriculum based on principles 1-8**
The writing of a curriculum may be undertaken by one person only, but the delivery will be undertaken by a group. 'Buy in' of staff is therefore required.
Application This development required a number of meetings and co-ordination. Staff development opportunities are now being offered to ensure that the curriculum can be delivered knowledgably and at the correct level. This does not relate just to the sustainability aspect of the curriculum, but to every aspect.

Table 6.3 Application of the principles of curriculum design to the JMU construction management programme

6.3.2.2. Overcoming barriers

When the idea of a full curriculum review from first principles was mooted amongst academic staff, there was a certain amount of consternation and worry that 'their subjects' might not be needed anymore. A great deal of reassurance was needed before there was assurance that this was not the case. Therefore the barrier that can create a fully input driven curriculum was removed. The problems of modularisation were overcome by utilising the project modules to allow application of skills and knowledge.

The programme has been mapped fully against the CIOB educational framework 2007 (given in the appendices) and there was space to spare to incorporate some staff specialisms. This counters the programme leaders from other universities views identified in phase 1 that the framework was too restrictive. The themes do not relate to staff specialisms but to generic learning outcomes for the programme, and these were allowed to develop once academic staff were given the reassurance that their skills were still useful and relevant. The issue of interdisciplinary learning was discussed at length and it was agreed that this needed to increase through the programme.

It was identified that the best students for the construction management students to work with were those involved in the design and management of construction. Building Design Technology and Management students deal with the management of design, but the School has no students that deal with the design of new buildings specifically. Therefore a decision was made to validate a new honours degree programme in Architectural Technology. This will recruit in September 2008, when the revised Construction Management programme will commence. These three groups of students will work together on projects in levels 1 and 2, and other programmes in level 3. The School has excellent links with industry and a concerted effort has been made to attain support for the programme via the supply of suitable real life case study materials. If the material is too complex it can be broken down into simpler tasks that students at each level will be able to utilise.

Personal Development Planning (PDP) is now a required part of UK Higher Education programmes, but the problem in the School of the Built Environment was how to deliver effective PDP with a large staff:student ratio. The solution was found in the form of the university virtual learning environment, e-portfolio system that can be customised for different student groups. For Built Environment students, competencies will be developed to allow knowledge, skills and attitudes to the environment and sustainability to be reflected and plans for future development be produced.

Issues relating to the level of research skills and knowledge development in the curriculum have been addressed by introducing the concepts in levels 1 and 2. Staff time issues are potentially a problem but a solution to this is out of the remit of this project as there is no system available that can replace individual student support and supervision on a one to one basis by academic staff.

During discussions about the development of the programme, several academic staff stated that they would be keen to develop the environmental modules that are completely new and teach students on programmes that they had never taught before. In addition a number of staff were willing to develop knowledge of sustainability in relation to their core subject. Where there was a lack of willingness to develop new skills and knowledge, the solution was found in the sharing of modules where someone with no interest would be supported by someone who was willing to develop (this was very much a minority problem).

In summary, all of the barriers that were identified in the literature review and phase 1 and 2 data analyses were overcome, some to a greater extent than others. This is a real life case study and all of these barriers could have prevented the model for curriculum development being implemented for the development of the construction management degree. However, with a good deal of team work and compromise all the principles were achieved.

6.4 Testing the model

The final phase of the research work is to test the applicability of the model to the construction industry, whether student knowledge of sustainable construction and design increases and attitudes to the environment improve over time. A test that would further validate the model would be to ascertain whether environmentally responsible behaviour develops in the graduates of the programme and whether they can make any real changes to industry practices. Potential model testing methodologies are given in table 6.4 along with how each method has been used to evaluate the effectiveness of the principles adopted in increasing knowledge and changes in attitudes in construction management students.

Aspect for testing	Issues related to testing aspect	Method of data collection
Applicability to industry	This could only be tested against perceptions of what is required now and not in the future and it has already been acknowledged that industry is not as knowledgeable and is not taking sufficient action as it should be.	A small number of questionnaires were issued to major graduate employers to gauge perceptions and validate previous research findings. This was intended to be a pilot study that would enable a survey on a much larger scale to be undertaken. Feedback from the validation panel on the curriculum. (the construction management representative on the validation panel is also the chair of the CIOB accreditation panel) This feedback was very positive and confirmed that the curriculum mapped against the framework and incorporated the CIOB recommendations for inclusion of sustainability in the curriculum.
Whether student knowledge of sustainable construction and design increases, and attitudes to the environment improve during study of the programme.	The revised programme will commence in September 2008 and therefore the first set of complete data would only be available in June 2012	This is the most important aspect to test as the aim of the research project was to produce a set of well defined concepts and principles relating to curriculum design that can improve sustainability literacy in graduates. Due to the time issue it was decided to simulate the findings of the model in a week long project for final year students. Knowledge and skill improvements and attitudinal changes can be mapped over the course of the project. If positive changes are observed in a small scale intervention, then over a longer term more radical changes should be observed. The rational for this method of testing, the methodology for the test and analysis of data are detailed in chapter7. The approach is supported by Tal(2005), Kaiser et.al(2007) and Meyers(2006)
Whether environmentally responsible behaviour develops in the graduates of the programme and whether they can make any real changes to industry practices	This would need to be a long term study because students would need to graduate and then become senior enough in their organisations that they are decision makers. It would therefore only be valid to start testing this aspect no earlier than June 2017.	No attempt has been made to assess this aspect.

Table 6.4 Timescales required for testing the model

6.4.1 Evaluation of industry feedback

In order to validate the findings of all previous data analysis, the literature review and to gain feedback on the relevance of the proposed interventions to industry in the future, a questionnaire was designed. It was envisaged that this questionnaire would be issued to a large sample of suitably qualified industrial practitioners and that this information could be analysed using statistical methods to assess whether variables made a difference to knowledge and perceptions. The questionnaire was piloted with a group of graduate employers who claim to have an interest in education and training and also have a background in construction management. The questions covered every aspect of the study to date and are included in the appendices. Twenty six questionnaires were received and the results of the pilot study are summarised as follows.

All the respondents hold a first degree and/or post graduate qualification, eighteen of the sample hold a professional qualification and seventeen are aged thirty or above. In addition all of the respondents work for organisations that would employ construction management students either in traditional construction management or design management roles and twenty one stated that it is their company recruitment policy to employ graduates, with six stating that sometimes and twenty two of the twenty six stating they would prefer graduate with cognate degrees. This indicates that the level of academic and professional qualification plus experience in the industry and organisational practices make this a valid sample.

Only one respondent was a Chartered Environmentalist and two are thinking of being. Thirteen stated that they had never heard of this which is interesting because both the RICS and CIOB had been advertising grand parenting schemes for a number of months before the questionnaire was issued. Fifteen respondents are members of these two professional bodies. Eight respondents stated that they did not want to be Chartered Environmentalists which may reflect a negative attitude to the environment. However, these responses were not supported by the fact that when asked if they were more concerned about environmental issues now than they were five years ago, twelve stated that they were more concerned and thirteen that they were far more concerned.

Twenty respondents disagreed or disagreed strongly that the construction industry has not changed practices that could improve environmental behaviour because if does not know how to. Seventeen disagreed or disagreed strongly that the industry has not changed practices because the government has not brought in legislation to enforce this. However seven did agree with this. This was contradicted by the reverse question when fifteen responded that the industry has changed practices because of government legislation and all but four stated that the government had not introduced enough legislation. There was then even further contradiction because twenty agreed or agreed strongly that the reason the industry had changed was because organisations are making changes within their organisations. The responses to the statement that industry has not changed its practices because it is purely profit driven were very varied and virtually evenly divided across the possible responses. A similar response pattern emerged for the statement regarding whether the construction industry had changed practices because clients are demanding this, but only four disagreed with the reverse statement.

There was a great deal of confusion when evaluating these responses, because the responses to the initial questions were then contradicted by the reverse question responses. It is very difficult to gauge what the overall feelings are as to how the industrialists believe the industry has reacted to sustainable practices.

The respondents were asked what they understood by the terms sustainable development, green design and sustainable construction. There were only a few responses that are summarised below:

Definitions for sustainable development included:

'Solutions and innovations that allow continual improvement, progress and development taking environmental costs and community considerations into account'.

(This statement was made by a human resources consultant not a construction professional)

'Development that will not adversely affect the planet's resources in the long term '

'Developing buildings that account for all internal energy costs met and reduce the carbon footprint '

The Brundlandt definition was quoted by the only Chartered Environmentalist

'Meeting the needs of clients today without affecting the needs of tomorrow' – this respondent did not define sustainable construction or green design.

'Using sustainable products and construction methods to promote buildings and meet occupier demands-' this respondent did not define sustainable construction or green design.

'Development that will not only form the environment but will improve it' -this respondent was not professionally qualified

'Development where buildings draw on scarce resources but the impact is minimal over the life of a building.'

'Using sustainable materials that can be re-grown and low Carbon dioxide emissions'

'Use of methods and systems which use reduced energy and resources'- this is a good quote but the respondent uses the same for the other two definitions.

'Triple bottom line'- this definition is used in the 'Draft Strategy for Sustainable Construction Consultation paper' (DfBERR, 2007) for sustainable design not development, which suggest that building design should contribute to environmental, social and economic sustainability.

'Building for the future?'

Green Design was defined as:

'Use of green materials, building methods, systems and design'
(This statement was made by a human resources consultant not a construction professional)

'Use of low embodied energy products that requires minimum energy usage'
(Response from the only Chartered Environmentalist)

'Design that minimises energy efficiency in use and carbon emissions both during the construction phase and the life of the building' – respondent not professionally qualified

'Design that allows for efficient energy usage over the life of the building'

'Use of solar and wind energy'

Sustainable Construction was defined as:

'Use of green materials, building methods, systems and design plus using green office practices as a whole, not on site but in the buildings they build and own'
(This statement was made by a human resources consultant not a construction professional)

'Respondent knew about the 3 pillar model- economic, social, economic and low embodied energy (Goodhew, 2003)- this actually refers to sustainable development*'*

'Mitigating the current impact on the environment by protection and preservation of the environment.'

'Construction using renewable resources'

The majority did not respond to these questions and a number who defined sustainable development did not then define green design and sustainable construction. The definitions for sustainable development were reasonably answered and the other two less so. The most accurate and informed responses to all three definitions were made by a Human Resources consultant who does not work at the cutting edge of construction activity. The other set of responses that were accurate and showed real knowledge of what the three definitions mean were from the only Chartered Environmentalist, which is to be expected. These responses and the lack of them illustrate that whilst a very basic knowledge of sustainable development is understood by some in the industry, an understanding of how sustainable development principles are translated into useable and understandable definitions of sustainable construction and green design is less obvious. This contradicts the responses that largely disagreed with the statement that the industry does not green itself because it does not know how to. What it illustrates is that what the industry believes it knows, is not what it needs to know. This supports the findings of phase 1 and 2.

The next set of data relates to the perceptions of industrialists of the construction higher education sector. Seventeen respondents stated they believe that Universities produce graduates with knowledge of the environmental impact of construction work, but that they need more and five stated that graduates do not have enough knowledge and need more. A similar pattern of responses related to the amount of knowledge students have about how to reduce the effects of construction work on the environment, and again for the level of skills graduates have for developing innovative solutions to solving problems in this field. There were however more positive responses regarding the level of graduate problem solving through team working skills. These responses validate the need for the research and the increase in environmental content of construction courses. They also verify the finding that team building and problem solving skills are very important in the construction curriculum. The importance of these findings are corroborated by the responses to the statement about the importance of the Higher Education sector in producing the construction professionals of the future, as all respondents stated 'important' or 'very important'. The sector therefore needs to increase student knowledge on environmental issues and develop skills that will enable innovative solutions to be made with regard to environmental protection. The only problem with these findings is that from the previous sets of responses it would appear that industry does not actually know what it needs graduates to know because it does not understand the issues itself.

The next set of statements related to the design of higher education construction courses. There was a majority agreement that a learning outcomes approach should be used for the design of programmes, but also strong support for the development of modules based on staff research interests and therefore input driven. The responses to these two questions indicate that the respondents had very little knowledge of curriculum design. The questions were probably unfair as the respondents are not working in higher education, but in mitigation the sample consists of employers who have very strong links with universities and should possibly have been more knowledgeable. Twelve respondents believe that the professional body should take the responsibility for curriculum design, eight had no opinion and only three disagreed and one strongly disagreed. The majority response was therefore in support of professional body input into the curriculum. Seventeen respondents stated neutral, disagree and strongly disagree to the statement that construction management degrees are educational programmes with a vocational theme and that training should be left to industry after graduation. In order to address these responses, construction management degree programmes would need to contain much more of a training element. However this approach to curriculum development would be queried by the Universities themselves as the consensus in academia is that a degree programme is an academic programme and the level of academic achievement has to mirror that of all University undergraduate programmes. The majority agreed that environmental subjects should be integrated into the main core subjects, but there was also a level of support for the notion of some fragmentation. There was also general agreement that programmes should have themes that run through the programme and that one of these themes should be sustainability.

The last two findings support aspects of 'The Future Paradigm for Sustainable Construction Curriculum Design Model' that was developed.

The respondents were asked how important they believe the following subjects are in the construction curriculum:

A. Building Costs and Prices
B. Programming and Planning of construction works
C. Management Systems
D. Health, Safety and Welfare in construction
E. Environmental knowledge and ability to apply knowledge in given scenarios
F. Ability to work with others
G. Information Technology
H. Communication skills
I. Materials Technology
J. Construction Law and Contracts
K. Construction Technology

The responses are summarised in table 6.5

20A	VI	I	N	20B	VI	I	20C	VI	I	N	NI	20D	VI	I	N	20E	VI	I	N	NI
	11	11	2		9	15		6	13	3	1		15	8	1		9	10	4	1

20F	VI	I	N	20G	VI	I	N	20H	VI	I	20I	VI	I	N	20J	VI	I	N	20K	VI	I	N
	13	10	1		10	10	4		16	8		10	8	6		8	15	1		12	8	4

Table 6.5 Level of importance placed on subjects in the construction curriculum

The two subjects that were only ranked as very important or important are programming and planning of construction works and communication skills and these are therefore deemed to be the most important subjects. By combining the number of responses for very important and important, three subjects scored equally, but taking the number of very important responses they can be ranked in order as health safety and welfare, ability to work with others and construction law and contracts. Next ranked was estimating and cost planning followed by construction technology and information technology. Environmental knowledge and ability to apply knowledge followed ranked slightly higher than management systems and finally materials technology was ranked as the lowest level of importance.

1. Programming and Planning of construction works
2. Communication skills
3. Health, Safety and Welfare in construction
4. Ability to work with others
5. Construction Law and Contracts
6. Building Costs and Prices
7. Construction Technology
8. Information Technology

9. Environmental knowledge and ability to apply knowledge in given scenarios
10. Management Systems
11. Materials Technology

This ranking illustrated a number of issues. Programming and planning of construction works are the key subjects of a construction management programme, but without a knowledge of construction technology these are impossible to understand and construction technology is only ranked seventh. Communication skills and the ability to work with others are essential in the construction industry and emphasise the need for group project work in the curriculum which is included in the model for curriculum design. Health and safety, law and contracts and building costs and prices are also major elements of a traditional construction management programme and would be expected to be high on the list. The interesting aspect is that the subjects where it has been previously identified that sustainability knowledge would most naturally be integrated are all ranked in the bottom half of the list—technology, management, materials science and environmental issues themselves. This contradicts the earlier responses that graduates need more environmental knowledge by ranking the subjects where the natural place for them to be included, in the lower half of the list.

The respondents were asked to supplement these responses by stating the level of importance there should be in including sustainability in the following subjects:

A. Building Costs and Prices
B. Programming and Planning of construction works
C. Management Systems
D. Health, Safety and Welfare in construction
E. Environmental studies
F. Ability to work with others
G. Information Technology
H. Communication skills
I. Materials Technology
J. Construction Law and Contracts
K. Construction Technology

The responses are summarised in table 6.6

21A	VI	I	N	NI	21B	VI	I	N	NI	21C	VI	I	N	NI	21D	VI	I	N	NI	21E	VI	I	N				
	13	7	3	1		9	6	7	2		11	6	5	2		12	7	4	1		15	7	2				
21F	VI	I	N	NI	21G	VI	I	N	NI	21H	VI	I	N	NI	21I	VI	I	N	21J	VI	I	N	NI	21K	VI	I	N
	10	3	9	2		8	8	6	2		7	7	8	2		17	5	2		6	6	11	1		15	7	2

Table 6.6 Level of importance of including sustainability in subjects

Using the same method of analysis as used for the previous set of data, the rankings are as follows:

1. Materials Technology
2. Environmental Studies and Construction Technology ranked equally
3. Building Costs and Prices
4. Health, Safety and Welfare in construction
5. Management Systems
6. Information Technology
7. Programming and Planning of construction works
8. Communication skills
9. Ability to work with others
10. Construction Law and Contracts

Some of these rankings concur with the findings of phase 2 with construction technology, materials and management ranking in the top five, but there are some anomalies. One of which is the low ranking of programming and planning of work, because this subject is ideal for developing knowledge of the application of environmental management systems to deliver sustainable construction. Health and safety and building costs and prices are not usually named as natural homes for sustainability to be included and yet they are ranked in the top five. The other rankings that are different from expected are for communication and working with others because the literature review and the findings of phases 1 and 2 strongly support the idea that environmental issues are best applied in group projects. The finding of the last two sets of data again illustrates a potential lack of knowledge of curriculum design by the respondents, and this is surprising given that the majority have undertaken cognate degree programmes. The results may be biased by their recollections of their studies as opposed to the current curriculum drivers.

The next set of questions was designed to establish perceptions of curriculum development. The responses relating to whether or not the respondents believed that university generated research fed into industry practices were mixed. Sixteen stated yes but not much and that they could only think of a couple of instance, four stated yes a lot and four that the answer was no, but that is because the industry is slow to adopt new practices and reticent to try new ideas developed via research. None stated that they believe that university research is too 'blue sky' or that the industry prefers to use research generated by outside bodies such as the Building Research Establishment. This was reassuring because industry does therefore see some value in university generated research and this bodes well for the future.

Unfortunately the majority of respondents were unaware or very unaware of the CIOB educational framework but those that stated they were aware believe that the framework is quite rigid, but does allow for each university to develop its own specialism within the curriculum. One believed that is it appropriate and that all subjects are incorporated to the right amount and level and one believed it to be quite rigid but also that this is not a bad thing. There was therefore support for the framework from the respondents who were aware of it. The findings contradict the responses from programme leaders in phase 1 who thought that it was too rigid, but the actual findings of phase 1 agree with the responses given in this questionnaire that there is some flexibility and each university can have some specialism input. The respondents were asked if they believe there is enough industry involvement in the design of construction curriculum. If they stated "yes" or "do not know" they were asked to move on, but if they stated "no" or "maybe" they were asked whether it was because:

A. Industry does not ask to be involved
B. Industry gets asked but does not get involved because of time constraints
C. Industrial interests in degree programmes tend to focus on the training aspects.
D. Academic research is the main driver of the curriculum.
E. Universities now employ people with research as opposed to industry backgrounds

There was no uniformity of response as shown in table 6.7

M	N	A	B	C	D	E
1		1				
	1		1			
1			1			
	1		1			
1		1				
1				1		
	1			1		
	1					1
	1	1				
	1					1
1						1
	1		1			
	1		1			
	1		1			
1					1	
	1	1				
1			1			
7	10	4	7	2	1	3

Table 6.7 Industry perspectives of engagement in curriculum design

Of the eleven that stated no, seven stated that the main reason given was that industry gets asked but does not get involved due to time constraints. Only two stated that industry does not get asked. These are likely to be very personal perspectives with those who believe they do not get asked never having been asked personally, and those claiming time constraints as being the problem may have been asked and not able to devote time to this. This could be the same issue for the two that stated that there are now more staff with research backgrounds as opposed to industrial. Their main contacts may have left and not been replaced by people with industrial backgrounds. The spread of responses was similar for those who stated "maybe", but there is a level of uncertainty in the validity of those replies because they only stated "maybe".

There was a majority agreement that within construction management programmes sustainability issues for all phases of the building life should be taught but with a lot of emphasis on focussing on the design and construction phases. There was also a consensus of agreement that real life case studies are useful in educational projects and that it is important that construction management students study with students on other programmes. The students that the respondents thought it best for them to study with, in rank order were, quantity surveyors, civil engineers and architects equally, building surveyors, planners, property managers and finally architectural technologists. This supported the model findings that interdisciplinary education is important and knowledge of both sustainable construction and design is important. However, the analysis of the findings of the phase 2 Australian data was that learning about design is best facilitated by learning with architects. Architects can be concept architects or technical architects, and it is therefore surprising that architectural technology was bottom of the list because these are the technical architects of the future.

When asked what the respondents thought would be the best way to change the attitudes of construction industry professionals towards promoting environmental construction practices, eleven respondents stated that it would be client demand for sustainable buildings and nine stated that it would need changes to regulation and policy. These were the majority answers, but neither of these relate to changing attitudes and the industry professionals undertaking initiatives without prompting. These factors are about being told to change and not about wanting to change. Only four stated that higher education study could achieve this and two that in house CPD was the answer which contradicts the earlier statements. All the respondents believed that the higher education sector is important or very important in providing the construction managers of the future and that studying environmental issues, technology and materials modules could increase knowledge that could change attitudes.

6.4.2 Summary and constraints

The construction management programme has been approved internally by an internal validation panel that ensured that it complies with university regulations, and that the level and standards expected of an undergraduate programme will be attained by students studying the programme. The panel also consisted of external representatives and as has been stated previously the representative for construction management is also the chair of the CIOB accreditation panel, and main developer of the educational framework. He confirmed that the programme maps against the framework. The programme also incorporates all the recommendations of the curriculum design model for enhancing literacy in sustainability and elements of other good practices.

A number of potential barriers to implementation had been identified and these were all overcome, some more readily than others. The aspect that needs more attention to allow further development over time is the inclusion of more interdisciplinary learning opportunities. These opportunities will only be identified when logistical implementation of the programme starts.

Possible testing of the model and verification of previous findings was divided into two potential categories:

1. Verification by industry
2. Assessment of student learning and attitude change after implementation

The first initiative was to be tested via the use of a well structured questionnaire sent out to a significant sample of the whole population of CIOB members. However the pilot of this questionnaire with a small sample and the subsequent analysis of the results deemed this to be an unsuccessful strategy. Although some of the responses verified earlier findings and supported the model, there are too many flaws to utilise this on a wider scale. The main problems were:

- Many of the respondents contradicted themselves in their responses to different questions and therefore it is impossible to decipher what they actually mean.
- There was evidence of a lack of knowledge of HE practice and curriculum design, which can be understood, but again makes the findings impossible to form conclusions from.
- In addition, the knowledge of sustainability relating to construction and buildings was much lower than anticipated; therefore making it difficult to gauge what is actually needed in the curriculum.
- If the questionnaire was sent out to a larger sample the validity of responses would be very questionable, some more than others. For example the questions related to industry input into the curriculum may only be answered by people who have not been asked to be involved, but many people may have been asked and had a significant input at different universities. For an industry as large as the construction industry, a very small percentage equates to a lot of people and there are only twenty two construction management programmes validated by the CIOB in the UK.

This is no criticism of the respondents but it does make the expanded use of the questionnaire unfeasible as it would be unsafe to form any conclusions from the results. It does mean that the major source of clarification of the suitability of the model to industry requirements rests with the professional body. Industry at the highest levels had a strong input into the development and revisions of the educational framework and the programme maps against it. Therefore it can be concluded that the programme has input from industry at the highest level and verification has proved satisfactory.

The second form of testing cannot be undertaken fully because of time constraints, but it is possible to simulate the model in a short intervention and test changes in knowledge, skills and attitudes. If improvements are seen in these areas then it can be surmised that the larger scale intervention will be more successful. The details of the methodology adopted, the project and the results of the intervention are detailed in chapter 7.

7.0 Phase 3-Model Evaluation

7.1 Methodology for testing

To test the findings that lead to the development of the Future Paradigm for Sustainable Construction Curriculum Design model and the implementation of the model at LJMU, a suitable test needed to be devised. Unfortunately the Construction Management programme is not due to commence until 2008 and therefore to test the curriculum was unviable within the time frame allowed for the PhD work. Therefore an alternative methodology for testing needed to be developed that could be implemented and results generated within the timescale allowed.

A review of potential testing tools was undertaken and the testing model adopted by Haase (2002) quoted in Seybold and Reiss (2006) was deemed to be the most appropriate and is supplemented by the work of a number of other writers. He examined the effects of a four day extra curricular educational programme called 'world rangers' that aimed to pedagogically contribute to sustainable development. It was designed as a pre and post test with student knowledge and attitudes tested using a questionnaire before the project commenced and then on completion. The results were used to assess the level of improvement and/or change in knowledge and attitudes.

His model was used for individual study but the use of group projects to achieve the same aims is supported by Tal (2005) who states that it is widely accepted that learning in environmental education occurs mainly in a social context, when learners interact and share ideas, thoughts and actions.

Lewis and Delcourt (1988) used a similar methodology to assess students' attitudes to computers, but they used a combination of questionnaires and interviews to collect their data. This enabled the benefits of both qualitative and quantitative approaches to be utilised fully and the disadvantages of each approach reduced. The use of both methods for testing was adopted for the evaluation of the model in this project and this combination of qualitative and quantitative data collection and analysis at each phase supports the notion that this research project fulfils the criteria for the work being classed as a mixed model methodology project throughout.

Karenauskaite and Juceviciene (2005) developed a 'Systematic Approach to Physics Study' (SAPS) that was considered in the context of realising the main principles of environmental education in the physics curriculum. Their research aimed to discover in what ways their systemic approach influences students' attitudes to (a) science and its importance to the study programme (b) teaching methods that influence student learning and (c) learning competence. The methodology of their research was based on two conceptual approaches, the learning paradigm and the constructivist approach to learning.

Learning is a process when people develop their knowledge, understanding, skills, values, attitudes and experience; it is not simply an output of teaching. The analysis of learning emphasises the need to provide a learner with effective learning means and tools, which meets their learning style and needs (Bowden and Marton, 1998).

The constructivist approach to learning is based on the belief that individuals construct new knowledge and meaning from experience. In addition the learner actively constructs knowledge from experience in their own personal learning environment which is not at the same time for everyone (De Corte , 2001).

By providing the opportunity for a group of students to undertake a project at the same time there is an impetus for them all to learn the same things at the same time. Karenauskaite and Juceviciene (2005) refer to these as control groups because they are subject to a simulation in a controlled environment.

These principles have been used to develop the test tool and in addition the findings of the previous PhD study work have also been incorporated into the test. The method used for the test was the simulation of the findings of recommendations of the Future Paradigm for Sustainable Construction Curriculum Design model in a one week long project undertaken by 187 final year students at LJMU. A quantitative approach was taken for pre and post testing but the amount of testing was increased by also using a mid project test. A supplementary test utilising qualitative data collection was also used to further support or disprove the findings of the analysis of the quantitative data.

As stated in 2.4, the research of Campbell Bradley et al (1999) showed that environmental knowledge improved significantly after an intensive ten day environmental science course, but although environmental attitude did improve the increase was not significant. This illustrated that factors other than formal education can influence attitude and the findings demonstrate a need for formal education programmes and educational interventions that are supported by Zelezney (1999). However it has been evidenced that ultimately education i.e. an increase in learning, is the most effective tool for changing attitudes, but attitudinal change takes longer than increase in knowledge. Therefore if changes in attitudes are less than increases in knowledge, the model may still be effective, but only in the longer term.

7.1.1 The project

The brief that was developed focussed on a proposed development project that was to be undertaken by a large locally based construction company. The company provided plans and building elevations for a multi storey residential development that had been produced by an architect. The plans formed the focus of the project and the student groups were asked to produce the following:

1. Proposals for changing the elevation appearance to the proposed apartment development and any proposed changes to layouts to be more in keeping with the locality.

2. Proposals including a design, for an additional, up to 3 storey development on the site. The proposal must contain a rationale as to why the type of building has been chosen and potential returns.

3. A basic cost plan that takes into consideration the proposed targeted value of the apartments. The target value needs to be clearly articulated and also how any changes made to the design will affect target value.

4. Proposals for how a 20% renewable energy target and achieving compliance with the recommendations made in the **Draft Strategy for Sustainable Construction: A consultation paper 2007** will be met.

5. A construction programme and health and safety plan for the works.

6. A whole life costing plan for 25 years after construction work is complete.

The project started on a Monday and finished on the following Friday and students were expected to attend full time for the week.

The methods used for assessment and subsequent data collection are shown in figure 7.1. The process assessment elements only were used for the data collection. The questionnaires were sent out electronically by email in the following order:

- Q1 was issued on the Friday prior to the project starting and had to be returned by 9am on the Monday that the project started
- Q2 was issued on the Wednesday afternoon and had to be returned by the next morning
- Q3 was issued on the final afternoon of the project and had to be returned by the following Monday.

Assessment Breakdown

Joint Project	
Product 50%	Process 50%
Project Report 35%	Completion of Qs 15%
Oral Presentation 15%	Individual Competency Audit 35%

Figure 7.1 Product and Process Assessment

The rationale for the timing of the issue of the questionnaires is that Q1 went out before the students knew what the project was about and therefore had no opportunity to do any research before the brief was issued. They therefore completed Q1 having had no concentrated environmental interventions to alter perceptions or enhance knowledge. Q2 was issued mid project and needed to be returned relatively quickly which meant less time to reflect and produce instinctive responses. Q3 was issued at the end of the project but not returned until the students had time to reflect on their knowledge and attitudes over the period of a weekend.

The individual competency audit had to be produced in the form of a 1000 word essay outlining the students' perceptions of their improvements in knowledge, changes in attitudes and reflection of the learning tools and environments that best engender learning of sustainability issues. This had to be submitted a week after the project was completed and was aimed at clarifying findings that the analysis of the quantitative data produced.

7.1.1.1 Mapping of the project brief and methodology for data collection against the findings of the model and other authors' approaches

The rationale for the approach taken and the design of the project is based upon previous research findings and the writings of other authors who have tested the effectiveness of interventions that could improve environmental literacy in students in a diverse range of subjects. The rationale for the choices made are summarised in tables 7.1a and 7.1b

THE TEST . **Reference**	**Application**
Haase (2002) used a four day simulation project which included pre and post testing.	The LJMU test used a five day project which included pre, mid and post project testing with a follow up test used a week after the project was completed.
Tal (2005) promotes the use of group projects in the test	In the LJMU test the simulation was undertaken by large multi disciplinary groups.
Lewis and Delcourt (1988) used a mixed model methodology approach to the collection of data	The LJMU test used a combination of qualitative and quantitative approaches to data collection and analysis.
Karenauskaite and Juceviciene (2005) cite the need for a controlled environment to under take the simulation	The project has very clearly outlined defined outcomes that had to completed within a strict timescale
Bowden and Marton (1998) state that learning is about developing knowledge, understanding, skills, values, attitudes and experience; it is not simply an output of teaching.	There was only a small amount of teaching in the week- 1 hour on the first day. The project aimed at developing all the areas that they identify as being required to achieve learning.

Table 7.1a Rationale for the design and implementation of the test

The Project Reference Using the principles of the curriculum design model	**Application**
Principle 1 The curriculum should be designed using Expected Learning Outcomes as the starting point.	The project learning outcomes were written with assistance from the industrial partner and contribute considerably to a number of programme learning objectives but specifically: *'After completion of the programme, students will have a knowledge of sustainable construction and design and skills to enable solutions for environmental problems to be developed'*
Principle 2 The curriculum should be holistic	As has been stated earlier it is difficult to design an holistic curriculum with the restrictions of a modular system. One of the solutions to this problem is the use of projects to bring together many themes and use the project to allow application.
Principle 3 Environmental aspects should be delivered via the curriculum in both integrated and fragmented ways.	The fragmentation comes from a short lecture on the first day that specifically focuses on sustainability. The integration comes from sustainability only being one outcome and many other course themes are also addressed.
Principle 4 The curriculum should be designed around themes	The project includes elements of all the themes of the programme. Technology, Law and Management, Science and Environment, Research, Application and Specialism
Principle 5 The curriculum should be designed to enable as much interdisciplinary learning as possible.	The project has been designed as a fully interdisciplinary project. More details on this aspect are given in 6.1.2
Principle 6 There should be opportunities to allow for the use of real life case studies in the curriculum to enhance the learning experience.	The focus of the project is an already designed development on a plot of land in Liverpool. Students can visit the site and the surrounding area and utilise drawings that have been produced by an architect. The initial design has been deemed as feasible by the developer.
Principle 7 There needs to be a mechanism embedded in the curriculum that will enable the students to reflect on preconceived beliefs and undertake a critical analysis of their attitudes to the environment.	The briefs for the completion of Q3 and the 1000 word essay clearly state that students need to reflect on their learning and attitude changes whilst undertaking the project.

Principle 8 There needs to be a mechanism embedded in the curriculum that will enable the students to develop and practice research skills	The brief for the project has been kept very basic and the information issued is deliberately minimal. This is to ensure that students need to use their research skills to retrieve the information required to complete the project.
Principle 9 The staff resource needs to be encouraged and developed to deliver a curriculum based on principles 1-8	Staff were required to be available to give support and advice to students during the week of the project. A deliberate decision was made to involve new staff who had never been involved with similar projects previously. Several meetings were held to brief these staff and they needed to undertake some background work to apply their specialist knowledge to the project and develop knowledge of their specialism from a sustainable perspective.

Table 7.1b Rationale for the design and implementation of the test

The methodology for the test is validated by the writings of other researchers in the field of environmental education. It is however supplemented significantly in the level of testing by the use of additional data collection over and above that collected by earlier writers and utilises elements of good practice from a number of different examples.

The test project can be mapped extensively against the curriculum design model. The project was interdisciplinary and therefore the brief had to be checked against the learning outcomes of the other programmes involved. Some minor changes needed to be made to ensure that this was the case.

A final further validation of the design of the project is that it covers sustainability at the design, construction and post occupancy stages. Although this is not an aspect that is covered in the curriculum design model, the DfBEE (2007) draft strategy for change, clearly identifies that for the construction industry to become sustainable it has to address sustainability at every phase of the building development and lifespan.

7.1.2 Student sample

As has already been stated the project was undertaken by 187 final year students studying programmes in the School of the Built Environment. The students were full time, part time and those that had undertaken an industrial training year are classed as sandwich students. At the outset of the project it was difficult to identify the sandwich students and as such they were classed as full time for the purpose of allocation into groups. Some of the disciplines were grouped because of small numbers and/or because of the similarity of the programmes. For the purpose of determining the participants in the interdisciplinary groups, the programmes and number of students under each classification are shown in table 7.2.

		Programme of Study				
		Construction Management	Quantity Surveying	Building Surveying	Real Estate Management	Total
Mode of Study	Full time	26	33	26	34	119
	Part time	6	12	7	0	25
	Sandwich	7	31	0	2	40
Total		39	76	33	36	184

Table 7.2 Student participants in the test project (student responses)

The groups were designed so that there were (as near as possible) an equal number from each grouping in the ten groups. The group sizes were either 18 or 19. These are classified as large groups but it was necessary for them to be this size to ensure that there were enough participants from each grouping for their discipline to have a significant impact on the outcomes of the project.

7.1.3 Data Collection methodologies

The approach to data collection in this phase was predominantly quantitative supplemented with qualitative. The use of questionnaires pre, mid and post test was employed to map changes in student knowledge, attitudes and approaches to learning whilst undertaking the project. The approach chosen aimed to assess the validity of the curriculum design model using a small scale simulation. The concept was that if there are changes when a small scale intervention is utilised, then the impact of implementation of the model in the context of the entire curriculum would be much greater. The production of the individual student essays form the qualitative element of the data collection, and this data was used to clarify findings of the quantitative data analysis and potentially find reasons why the results were as they were.

7.1.3.1 Quantitative data collection methodology

The quantitative data collection was via questionnaires issued on line, pre, mid term and post test. The questions were predominantly the same so that comparisons could be made of any change in knowledge, attitudes and learning experience. However Q3 asked some additional questions that included a greater measure of opinion that would allow responses that were possibly tempered after a mellowing period.

Q1 was issued before the project started and the students had no knowledge of what the project would entail. Q2 was issued at the busiest time of the project when tensions tend to be high, and Q3 was issued after all the hard work was over. This needed to be considered when reviewing responses, and any anomalies in the data that the timing of issue may have caused had to be reviewed using the supplementary qualitative data.

The design of the questions was undertaken using the guidance given by George and Cowan (1999) for obtaining information about student reactions of an experience. They were predominantly closed questions although some are closed and then followed by a follow on question in an open ended format. The benefit of open ended questions is that they allow students to express views in a fuller statement. However because the quantitative data collection was supplemented by a qualitative approach which would enable students to express themselves fully, the majority of the questions are closed for ease of answering.

George and Cowan (1999) state that questions should be:

- Short and deal with a single point
- Clear and lacking in jargon and ambiguity
- Such that they do not lead to an expected answer
- Written in a positive form
- Free from questioner's bias

To ensure that all these recommendations were met, the questionnaires were piloted before they were issued with LJMU academic staff and only slight amendments made after the piloting exercise.

The questions were developed under section headings with each section of questions aimed at capturing certain elements of data. The first five questions were asked to identify independent variables to allow for a statistical analysis of the data. The questions were aimed at determining if the mode of study, programme of study, gender, age and existing interest in environmental issues made any difference to responses. Salkind (2004) recommends that no more than five independent variables are used if accuracy in analysis is to be achieved because the power of prediction reduces with any more variables. This determination of variables and subsequent analysis of data comparing responses grouped under the various variable headings is sometimes referred to as multiple regression and the variables where there are differences in responses can easily be observed (Lyytinen et.al, 1998).

The other sections of questions were aimed at assessing environmental awareness, attitudes to environmental issues, knowledge of environmental issues and perceptions of the benefits of different learning styles.

The majority of the questions used Likert- type scales with responses from 1-5 to enable students to illustrate depth of feeling, opinion or knowledge. The use of a Likert scale allows a qualitative response, a cognitive attitude statement, to be used as a quantitative variable for analysis (Oppenheim, 1992). Most Likert scale question responses have four or five possible answers. The disadvantage of most five scale answers is that they include a 'no opinion' or 'neutral' option in the middle of the scale. The advantage of a five point scale is that it allows for more analysis options. The decision was made to use a five point scale for the majority of questions of this type, but instead of a neutral point, the possible answers would give scaled responses to ensure that they all required the student to have an opinion.

Some of the questions use a ranking scale where participants are asked to rank a number of possible alternatives numerically in terms of importance. This allows a very simple and yet effective statistical method to be applied to gain the overall average view of a group and sub sets of a group by using mean calculations and standard deviations. The means calculated can be compared under the different variable groupings using a statistical test to see if the variable makes a difference to the mean score, but also the mean scores generated for the whole group and subgroups can be compared using a statistical test to ascertain whether there is any statistically significant difference in the responses of the three questionnaires.

The questions asked to assess knowledge included elements of both types of approach. For example, to ascertain knowledge of the impact of different procurement processes in promoting sustainable construction practice, the statement posed was:

"How would you rank the following procurement methods between 1 and 6 (1 being the highest), as to how effective they are for encouraging the use of sustainable construction techniques." (Please use each number once only)

Possible responses are given below in table 7.3

	Very Good	**Good**	**Average**	**Not that good**	**Don't know**
Design and Build					
Construction Management(contract or acts as a consultant)					
Private Finance Initiative (PFI)					
Traditional (open or selective tendering)					
Partnering					
Whole life value approaches					

Table 7.3 Possible responses to the impact of alternative procurement options on promoting sustainability

This type of approach uses a Likert scale as there are five potential answers that can be chosen, and the majority will use this as a ranking scheme. However the main difference is that with this set of responses there are right and wrong answers, not just perceptions, which the questionnaire author knows because of previous research work. The questions had to be carefully developed to ensure that there were no answers that were obviously right or wrong, and that the decision as to which are the correct answers was carefully considered. This type of questioning was used in phase 1, proved successful and was therefore used again. The analysis of this data could be threefold, assessment if there was a difference in knowledge between the different variable groupings, mean calculations of how the groups and subgroups rank the different systems, and how knowledgeable the group or subgroups are by how far away they are from the correct answer. This can be done three times in the pre, mid point and post tests to assess changes in knowledge over the duration of the project.

This approach to data collection is supported by the work of Brody and Ryu(2006) and Kaiser et al (2007) and the three questionnaires are given in the appendices.

7.1.3.2 Qualitative data collection methodology

Below is the brief set for the individual competency audit that the students had to submit a week after the project was completed:

At the end of this process (undertaking the project) you should reflect upon your experiences and use your records of competence development as an aid in preparing the Reflective Critical Review. The critical review will take the form of an 1000 word essay in 3 parts which should:

1. *Outline skills competency at the beginning of the project, skills competency at the end of the project and plans for how you will further develop these skills in the future.*
2. *Detail your knowledge of sustainable construction work and buildings at the beginning and end of the project.*
3. *Explain any change in your attitude to environmental issues, both personally and within the context of your chosen career.*

These essays were submitted electronically and form the basis of the supplementary qualitative data. This also forms the part of the project that maps against principle 7 of the curriculum model.

'There needs to be a mechanism embedded in the curriculum that will enable the students to reflect on preconceived beliefs and undertake a critical analysis of their attitudes to the environment.'

The project was extremely fast track and the reason for requesting submission a week after the project was completed was to enable the students to have time to reflect adequately. This approach to data collection is supported by the work of Reis and Roth (2007) and Lewis and Delcourt (1988)

The essays have been reviewed and potential explanations to some of the findings of the quantitative data analysis identified.

7.2 Data analysis

The data collected from the pre, mid and post project questionnaires was collated on an excel spreadsheet and imported into the SPSS (Statistical Package for Social Sciences) software. The research project concentrates on construction management programmes but in order to generate the amount of data required to undertake statistical analysis, all students involved in the project completed questionnaires. The Building Surveying and Quantity Surveying programmes have a great deal in common with the Construction Management programme and therefore the findings of the data collection and subsequent analysis should be relevant to the findings.

The testing undertaken required the evaluation of whether there were statistically significant differences between the responses of different variable groupings at each stage of testing and whether there were statistically significant differences to responses at the different stages of the project. This is shown diagrammatically in figure 7.2 using comparison by mode of study as an example for comparing responses of different variable groups.

The techniques used to analyse the data are usually used when interval data has been collected. However there is support for the use of these techniques for the analysis of ordinal data that was collected in this phase.

The research hypothesis to be tested during the project was:

'Knowledge will increase rapidly, but attitudes will change slowly'

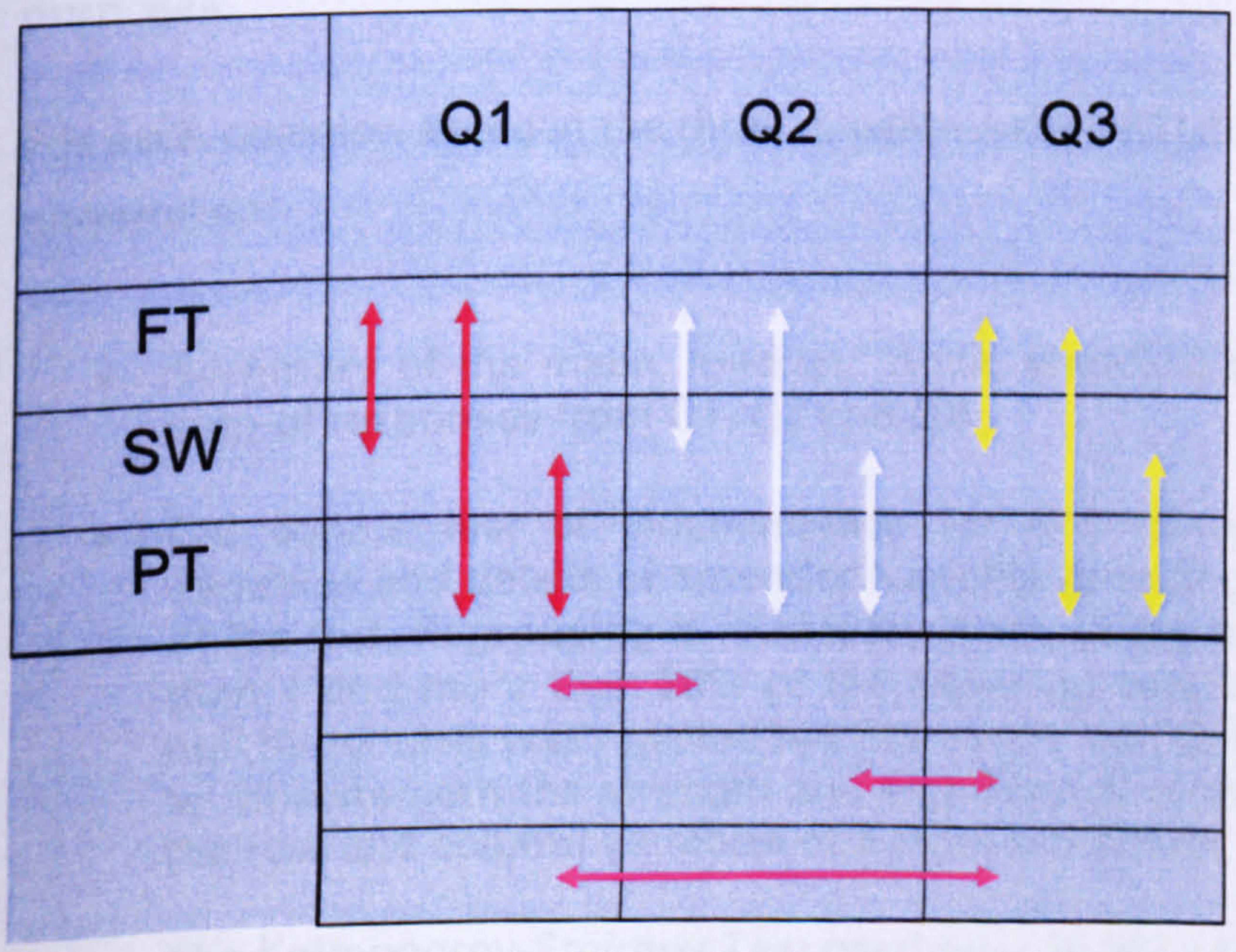


Figure 7.2 Statistically significant testing undertaken

The potential statistical tests that could be used for confirmation of findings were based on the recommendations of Field (2000) and Bryman and Cramer (1997) which are summarised in table 7.4.

What do you want to do?	**Parametric Test**	**Non-Parametric Test**
Test whether the averages of two samples are the same	Independent samples t-test	Mann- Whitney u Test
Test whether 'before' and 'after' measurements on the same sample have the same averages	Paired sample t-tests	Wilcoxon signed-rank test
Test whether the average of a sample equals a known value X	One sample t-test	One sample t-test
Test whether the averages of several independent samples are the same	One way ANOVA	Jonckhere-Terpstra Test Kruskal-Wallis Test
Test whether there is association between factors	Chi-square test of independence	Chi-square test of independence

Table 7.4 Suitable and potential statistical tests available to analyse data

After consideration, the tests highlighted in red were deemed to be the most suitable for the data collected at different stages of the analysis for different purposes.

For each question asked in the three questionnaires (Q1,Q2,Q3) the following was undertaken:

- Summary of the mean, median, mode, standard deviation, variation and sum of responses from Q1, Q2 and Q3

- Chi square test of independence for Q1, Q2 and Q3 using relevant variables and details of amended variable groupings to ensure the validity of the test. Regrouping is necessary if any of the expected values are less than 1 and more than 20% of the expected values are less than 5. If the null hypothesis was rejected the Cramers'V and Gamma test were adopted to indicate both the strength and significance of the relationship between the row and column variables of a cross tabulation.

- The Kolmogorov-Smirnov Test used prior to the analysis of the differences between Q1-2, Q2-3 and Q1-3, to determine whether the data has a normal distribution. If the significance level achieved by the test is less than 0.05 the null hypothesis is rejected and the sample is drawn from a population that is not normally distributed and a non parametric test needs to be used. If the data has a normal distribution then the more powerful parametric paired sample t-test can be used, but if not then the Wilcoxon signed-ranks test is used.

- Comparison of the results obtained from Q1, Q2 and Q3.
- Descriptive statistic charts where relevant

The results of the findings are discussed in this chapter and are supplemented by charts produced using excel to identify trends occurring in the data and SPSS output data. Graphs that summarise the main changes to awareness, knowledge, attitudes and learning styles have been produced to validate whether the model implemented achieves improvements and changes in these fields in a short term intervention and the a statistical test is used to establish whether the differences are statistically significant.

The hypotheses tested statistically under each variable are given in table 7.5.

Unfortunately the small number of female students meant that statistical testing by gender proved impossible.

Variable	Awareness	Attitudes Positive	Attitudes Negative	Knowledge	Education
Mode of study	Ho-PT students will be more aware of environmental issues in construction	Ho-PT students will be less positive than FT	Ho-FT students will be less negative than PT	Ho-FT students will be less knowledgeable than PT	Ho-there will be no difference between different modes of study
Programme	Ho-there will be no difference between different programme areas	Ho-there will be no difference between different programme areas	Ho-there will be no difference between different programme areas	Ho-there will be no difference between different programme areas	Ho-there will be no difference between different programme areas
Age	Ho-there will be no difference between age groups	Ho-there will be no difference between age groups	Ho-there will be no difference between age groups	Ho-there will be no difference between age groups	Ho-there will be no difference between age groups
Environmental Interest	Ho-those who state no will be less aware	Ho-those who state no will be less positive	Ho-those who state yes will be less negative	Ho-those who state no will be less knowledgeable	Ho-there will be no difference between the groups
Changes over time					
Q1-Q2	Ho- There will be an increase in awareness between Q1 and Q2	Ho- There will be an increase in positive attitudes between Q1 and Q2	Ho- There will be a reduction in negative attitudes between Q1 and Q2	Ho- There will be an increase in knowledge between Q1 and Q2	Ho- There will be a change in attitude to learning styles between Q1 and Q2
Q2-Q3	Ho- There will be an increase in awareness between Q2 and Q3	Ho- There will be an increase in positive attitudes between Q2 and Q3	Ho- There will be a reduction in negative attitudes between Q2 and Q3	Ho- There will be an increase in knowledge between Q2 and Q3	Ho- There will be a change in attitude to learning styles between Q2 and Q3
Q1-Q3	Ho- There will be an increase in awareness between Q1 and Q3	Ho- There will be an increase in positive attitudes between Q1 and Q3	Ho- There will be a reduction in negative attitudes between Q1 and Q3	Ho- There will be an increase in knowledge between Q1 and Q3	Ho- There will be a change in attitude to learning styles between Q2 and Q3

Table 7.5 Hypotheses to be tested using SPSS

7.2.1 Interpretation of data

The data collected has been initially considered and charts produced to describe the main findings using different measures such as the mean calculation, number of specific responses or valid percentages of total responses. The production of these charts ensures that the data can be easily interpreted and results presented in a clear and concise way. As Salkind (2004) claims:

'A picture really is worth a thousand words'

However in order to determine the validity of the findings and the true representativeness of the data it needs to be tested for significance. In the context of statistical analysis, significance means that the difference between the values calculated is due to some systematic influence and not merely chance. However some leeway in confidence in the affect of only the factors identified causing difference between groupings and results is acceptable. This means that the level of risk of claiming differences that could be marred by the possibility of flaws in the data is removed. The level of risk is expressed as the significance level and is the risk associated with not being 100% confident that what is observed from the data collected is due to factors other than those that have been considered. For example if it is stated that significant findings occurred at the .05 level ($p<.05$ or 5%), then there is a 1 in 20 chance that differences found were not due to the hypothesised reason but for some other reason. Statistical significance is the degree of risk a researcher is willing to take that the null hypothesis will be rejected when it is actually true (Salkind, 2004).

Manual calculations for significance levels means that only one figure can be used i.e. $p<.05$ which is a relatively standard figure used in construction management and educational research. However by using a computer package such as SPSS it enables the exact significance level to be calculated and the value of p is equal to anything between .00 and .0499999999 ad infinitum.

The statistical tests employed in this project have been used to determine whether observed findings are statistically significant i.e. whether the results of one set of results are indeed different to another set, and whether that difference is significant enough to claim that it is so. Unfortunately none of the data collected followed a normal distribution pattern and as such less powerful non-parametric tests have been used to determine statistical significance.

7.2.1.1 Central tendency and dispersion calculations

Central tendency calculations are used to identify the value that best represents an entire group. They are known as the mean, the median and mode values for sets of data. The mean is calculated by adding all the values in a set of data together and then dividing this figure by the number of data points. The median is obtained by determining the midpoint of a set of scores and the mode is determined by identifying the most common score in a set of data. The mean score should be used when data does not have extreme scores that can distort the average and in the data collection for this research project, responses could only be between 1 and 5 in the majority of cases. Therefore there are no very extreme responses possible and as such the mean has been used predominantly as the measure of central tendency. The mode is generally used when data is not numerical in nature for example type of car people have. However this data can be classified numerically and therefore the mode could be used and is referred to for some responses. The median is generally used when extreme scores are recorded and the mean could be affected significantly enough by these extreme scores to distort the mean value.

Mean calculations have been used predominantly to plot data for descriptive purposes, and the figures used give a good representation of the perceptions and knowledge across the whole population of the student group. However mean values cannot be used as exclusive measures for the overall responses given.

The level of variability (dispersion) also needs referring to and the measure used is the standard deviation. The standard deviation for a set of results is the average amount of variability in a set of scores. The higher the standard deviation, the larger the average distance there is from the mean to each data point (Salkind, 2004). This measure is important because the lower the standard deviation the more representative the mean becomes. A high standard deviation indicates that there is a lot of difference between scores and a different measure of central tendency may be more appropriate.

Where mean values have been used to plot results, the standard deviation is also discussed to assess the validity of the mean calculation.

7.2.1.2 Chi-square tests

The aims of using the Chi-square test and the concepts employed using this test have been discussed previously in chapter 4. The Chi-square test was used to analyse the quantitative data in phase 1 but an excel spreadsheet was used rather than using SPSS data outputs.

The chi-square measures test the hypothesis that the row and column variables in a cross tabulation are independent. While the chi-square measures may indicate that there is a relationship between two variables, they do not indicate the strength or direction of the relationship. Nominal directional measures need to be adopted to indicate both the strength and significance of the relationship between the row and column variables of a cross tabulation. After reviewing the writings of Funk (1995), Cohen and Holliday (1982), De Vaus (1999) and Bryman and Cramer (1997) the measures of association deemed to be most suitable for use with nominal (age, gender, programme etc.) data analysed against ordinal (Likert scale) are the Phi, Cramer's V (nominal) and Gamma (ordinal) tests. However the Phi test can only be used when a 2x2 Chi square cross tabulation table is produced and this was not the case in any of the analysis undertaken for the project. The nominal variable test (Cramer's V) is the weaker of the two tests and as such this should be used to justify findings. An example of the data output with explanation of terms is given in the appendices.

A Cramer's V and/or Gamma value rating of up to 0.3 indicates a weak relationship, 0.4-0.6 indicates a moderate relationship and 0.6+ indicates a strong relationship.

7.2.1.3 One sample Kolmogorov-Smirnov test

This test is used to determine whether data to be tested follows a normal distribution. If it does then a parametric test can be used to test the data, if not then a less powerful non parametric test must be used. The Kolmogorov-Smirnov Test compares an observed cumulative distribution function to a theoretical cumulative distribution. An example and explanation of SPSS output for the Kolmogorov-Smirnov test is given in the appendices.

7.2.1.4 Wilcoxon signed rank tests

The Wilcoxon signed ranks test is used to test whether before and after measurements taken on a sample have the same average. It is used when the data is continuous as the data collected for this project in phase 3 is. It is a non-parametric test which is not as powerful as the paired sample t-test that could be used if the data followed a normal distribution, but is still powerful in assessing whether the differences between responses in questionnaires 1, 2 and 3 are statistically significant. The Wilcoxon Signed-Rank test detects differences in the distributions of two related variables.

An example and explanation of SPSS output for the Wilcoxon Signed-Rank test is given in the appendices.

7.2.2 Results

The results from the data analysis for phase 3 are detailed under four main headings: awareness, knowledge, attitudes and approach to learning. The findings attained from the relevant student questionnaire questions are detailed and supplemented by statements made in the individual student submissions. This use of analysed and combined qualitative and quantitative data to ascertain the main trends in the data supports the methodological approach adopted for this project which is mixed model.

Analysis of data was undertaken for the whole group and in some instances for construction management students only. The initial questions were asked to determine variables to enable analysis to be undertaken. The variables used and the reason for their choice are as follows:

The mode of study was requested and it was envisaged that part time or sandwich students would have different knowledge, attitudes and awareness of environmental issues relating to construction and buildings than full time students because of exposure to the industry. The breakdown by mode is given in table 7.6

Mode

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	FT	135	61.9	67.5	67.5
	SW	25	11.5	12.5	80.0
	PT	40	18.3	20.0	100.0
	Total	200	91.7	100.0	
Missing	System	18	8.3		
Total		218	100.0		

Table 7.6 Breakdown of students by mode of study

Students were asked to identify their programme of study as some differences in knowledge were expected due to the curricula differences between programmes. The split of the students by programme is given in table 7.7.

Programme

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	CM	41	18.8	20.4	20.4
	QS	81	37.2	40.3	60.7
	BS	38	17.4	18.9	79.6
	REM	41	18.8	20.4	100.0
	Total	201	92.2	100.0	
Missing	System	17	7.8		
Total		218	100.0		

Table 7.7 Breakdown of students by programme of study

The age breakdown of students was ascertained to establish whether younger students had different attitudes to the environment than more mature students. The age breakdown for the student group is given in table 7.8

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Under 25	148	67.9	73.3	73.3
	25-29	31	14.2	15.3	88.6
	30-39	16	7.3	7.9	96.5
	40-49	7	3.2	3.5	100.0
	Total	202	92.7	100.0	
Missing	System	16	7.3		
Total		218	100.0		

Table 7.8 Breakdown of students by age

As can be seen the majority of students are aged under 25. To facilitate statistical analysis of data, the age bandings were changed to under 25 and over 25 only to give sufficient numbers in both groups.

Finally the students were asked if their dissertation had an environmental or sustainability focus. The hypothesis was that students who had chosen a topic in these areas would be more knowledgeable and aware of issues and would have more positive attitudes to the environment. The breakdown by prior environmental interest is given in table 7.9

Priorenvironmental interest

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	56	25.7	28.0	28.0
	No	144	66.1	72.0	100.0
	Total	200	91.7	100.0	
Missing	System	18	8.3		
Total		218	100.0		

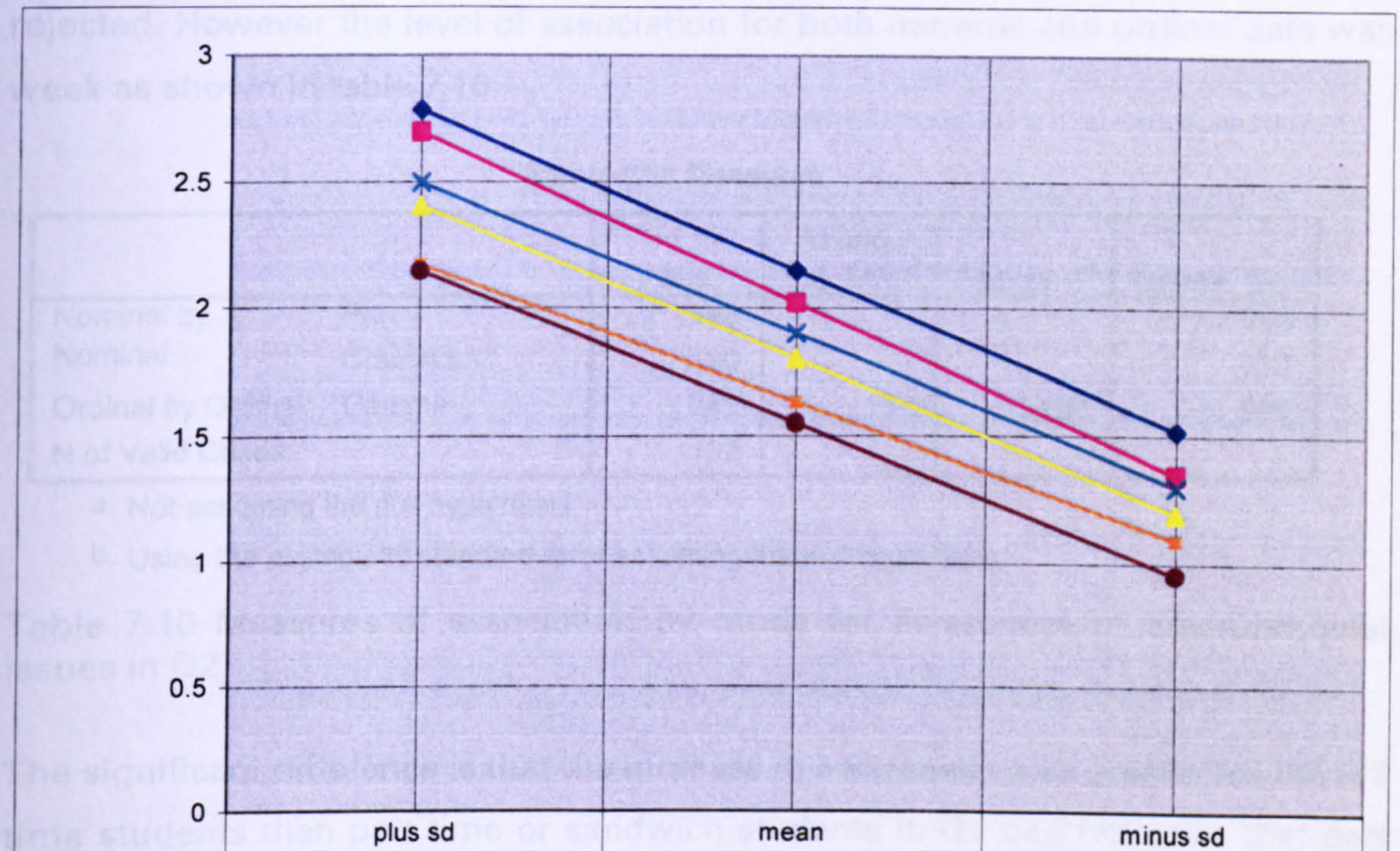
Table 7.9 Breakdown of students by prior environmental interest

Thus the main variables that Tikka et al (2000) identified as being the most important when testing for environmental awareness and attitudes were able to be identified, except for gender.

In the following sections the results of the analysis of the quantitative data collected are discussed. The pre test questionnaire is referred to as Q1, the mid test questionnaire as Q2 and the post test questionnaire as Q3.

7.2.2.1 Awareness

Students were asked to rate their awareness of environmental issues at pre, mid and post test stages. The measures of central tendency were calculated and the mean results plus standard deviations for the whole sample and construction management students only are illustrated in chart 7.1



	plus sd	mean	minus sd
Q1	2.782	2.15	1.518
Q2	2.695	2.02	1.345
Q3	2.406	1.8	1.194
CM Q1	2.498	1.9	1.302
CM Q2	2.171	1.63	1.089
CMQ3	2.147	1.55	0.953

Chart 7.1 Student awareness of environmental issues

A reduction in the mean value indicates an increase in environmental awareness and there is a reduction in the mean for both the total sample and the construction management group from both pre to mid and mid to post stages. Construction management students stated a higher level of awareness than the total sample at all three stages. However the standard deviation at all stages is high for both groups indicating that there is a wide range of responses. The modal and median values for the three questionnaires for the whole sample and construction management questionnaires 1 and 2 are both two, however in Q3 for the construction management students the mode is one, indicating that the majority of students rated their level of awareness having increased from aware to very aware.

At the pre test stage there was no statistically significant difference in response by mode but at the mod test stage there was and the null hypothesis was rejected. However the level of association for both nominal and ordinal data was weak as shown in table 7.10

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.196			.030
	Cramer's V	.196			.030
Ordinal by Ordinal	Gamma	.241	.137	1.722	.085
N of Valid Cases		182			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 7.10 Measures of association by mode for awareness of environmental issues in Q2

The significant difference is that the increase in awareness was greater for the full time students than part time or sandwich students in Q2 and indicates that part time and sandwich students were more aware of issues at the start of the project than the full time students because of their exposure to industry.

At the post test stage it was not possible to test whether there was any significant difference in response by mode because for the whole sample awareness had increased to an extent that regrouping of classifications was not possible for a valid test to be undertaken.

At the pre and mid test stages there was a statistically significant difference in responses by programme, and the difference was more pronounced at the mid test stage as the pearson chi square value reduced from .009 to .000. However the level of association determined that this significance was weak as shown in table 7.11

The significant difference was that the construction management and building surveying students scored higher in the awareness ratings than the expected counts indicating a higher level of awareness than quantity surveying or real estate management students. As construction management and building surveying students are the two programmes predominantly involved in design and construction this result is very positive. As with the figures for difference by mode, statistical testing for differences by programme was not possible at the post test stage because of the generic improvement of ranking of awareness.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.314			.006
	Cramer's V	.222			.006
Ordinal by Ordinal	Gamma	.218	.103	2.099	.036
N of Valid Cases		186			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.380			.000
	Cramer's V	.269			.000
Ordinal by Ordinal	Gamma	.247	.095	2.508	.012
N of Valid Cases		183			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 7.11 Measures of association by programme for awareness of environmental issues in Q1 and Q2

At the pre and mid test stages there was no statistically significant difference in responses by age and again at post test stage it was not possible to test the results.

At pre, mid and post test stages there was a statistically significant difference in response by students who claimed to have a prior environmental interest, as was to be expected. At pre test stage the significance level was .041 and this reduced to .009 at mid stage, indicating that students with prior environmental knowledge felt even more aware than those without at the mid stage. However this figure then increased to 0.033 at post test stage which indicates that the students with no prior interest had seen a higher raising of awareness between

the mid and post tests. However as shown in table 7.12 the association at all three stages is weak with all three figures for Cramer's V being under 0.3.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.190			.066
	Cramer's V	.190			.066
Ordinal by Ordinal	Gamma	.372	.129	2.711	.007
N of Valid Cases		199			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.217			.072
	Cramer's V	.217			.072
Ordinal by Ordinal	Gamma	.437	.128	3.047	.002
N of Valid Cases		182			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.163			.097
	Cramer's V	.163			.097
Ordinal by Ordinal	Gamma	-.161	.152	-1.053	.292
N of Valid Cases		175			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 7.12 Measures of association by prior environmental interest in Q1, Q2 and Q3

The kolmogorov-smirnov test was undertaken for the responses in Q1, Q2 and Q3 and the significance for all three sets of results was .000 indicating that the null hypothesis was rejected and therefore the data did not follow a normal distribution. The use of the non parametric Wilcoxon signed ranks test was therefore used to test for significant differences between the responses at the three stages. Between stages 1 and 2 the significance level was .003, between stages 2 and 3 it was .048 and between stages 1 and 3 it was .000 indicating that there was a bigger difference between stages 1 and 2 than stages 2 and 3 which indicate a high level of awareness raising at the beginning of the project which was to be expected, and the overall awareness raising from the start to the finish being highly statistically significant.

The difference for the construction management group only was less marked with the significance value between pre and mid test being .019 as opposed to .003. Between the mid and post test stages and the pre and post test stages, there was no statistically significant difference for this group only, indicating that they claimed to be aware at the start of the project and this awareness remained relatively constant.

A second question asked to ascertain student awareness of environmental issues was to determine whether they believed that the construction industry posed a threat to the environment. The valid percent responses are shown in chart 7.2

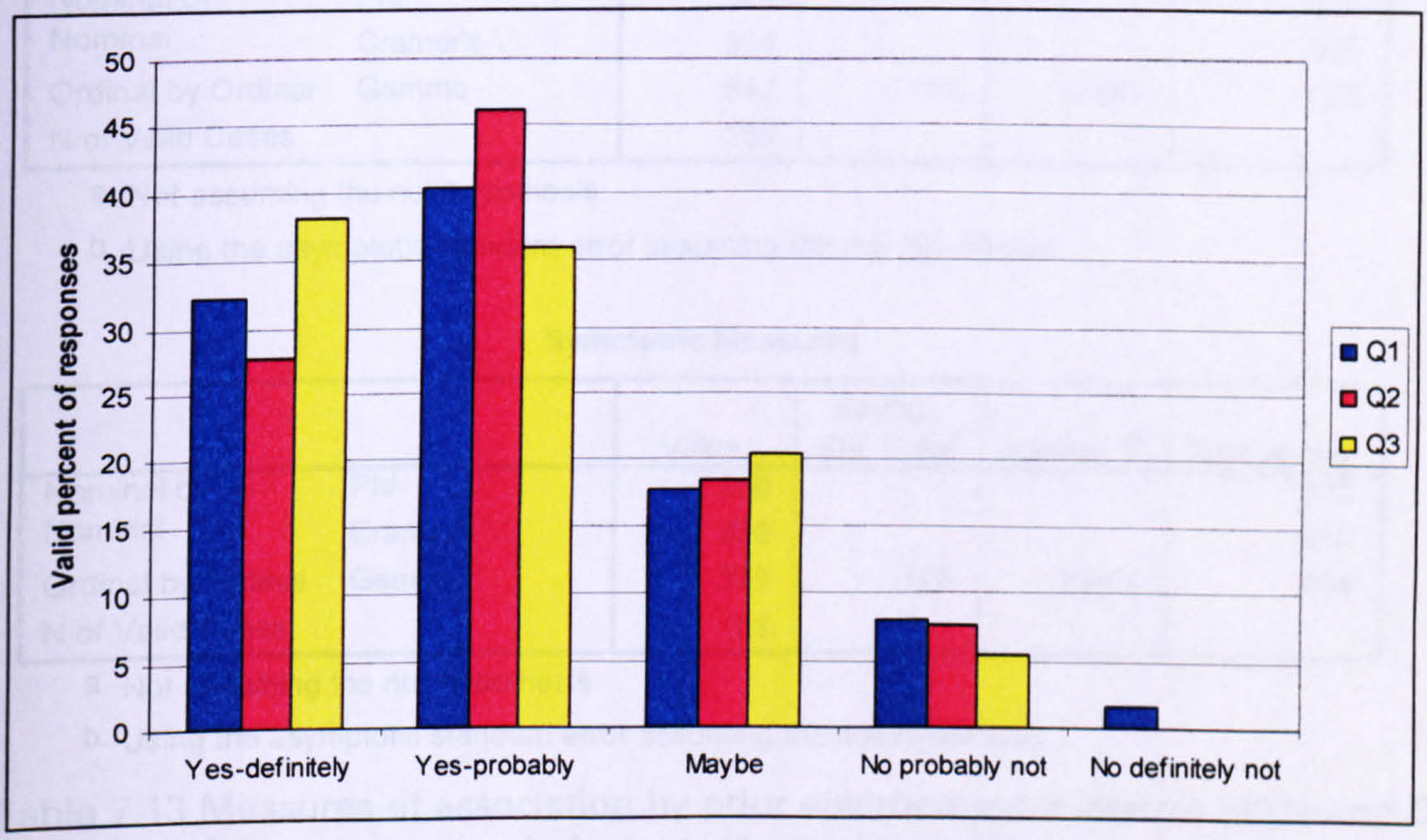


Chart 7.2 Student perceptions of whether the construction industry impacts on the environment

These responses indicate that by the end of the project the majority of students' perceptions had changed with a marked increase in the 'yes definitely' responses, and no students responding as 'no definitely not' at the mid and post test stages. However there was no statistically significant difference by mode of study, programme or age at any of the stages.

As expected, there was a significant difference in both the pre and mid test responses between those students who claimed a prior environmental interest and those that claimed no to have. The significance level at pre test stage was

.000 and at the mid stage was .010 indicating that there was less of a difference by mid way through the project. At the post test stage there was no statistically significant difference, indicating that the students with no prior environmental interest had developed an awareness of the threat of the construction industry similar to those that had previous awareness through their dissertation work. However as shown in table 7.13 the measure of significance for the differences in Qs 1 and 2 is weak.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.324			.000
	Cramer's V	.324			.000
Ordinal by Ordinal	Gamma	.547	.105	4.547	.000
N of Valid Cases		185			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.250			.010
	Cramer's V	.250			.010
Ordinal by Ordinal	Gamma	.379	.126	2.864	.004
N of Valid Cases		183			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 7.13 Measures of association by prior environmental interest in Q1 and Q2 for threat of the construction industry to the environment

The Wilcoxon signed ranks test showed that between pre and mid tests there was no significant difference between the responses, but that there was a significant difference between mid and post testing as shown in table 7.14. The reason for this was the increase in responses stating that the students believed that the industry has more impact than they thought originally as the project progressed.

Test Statistics[b]

	Q13 - Q13	Q13 - Q13
Z	-.025[a]	-6.753[a]
Asymp. Sig. (2-tailed)	.980	.000

a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test

Table 7.14 Wicoxon signed ranks test for differences in responses between Q1 and Q2, and Q2 and Q3-Impact of the construction industry on the environment

The students were asked whether they believed that the construction industry does enough to protect the environment. The valid percentage responses are given in chart 7.3

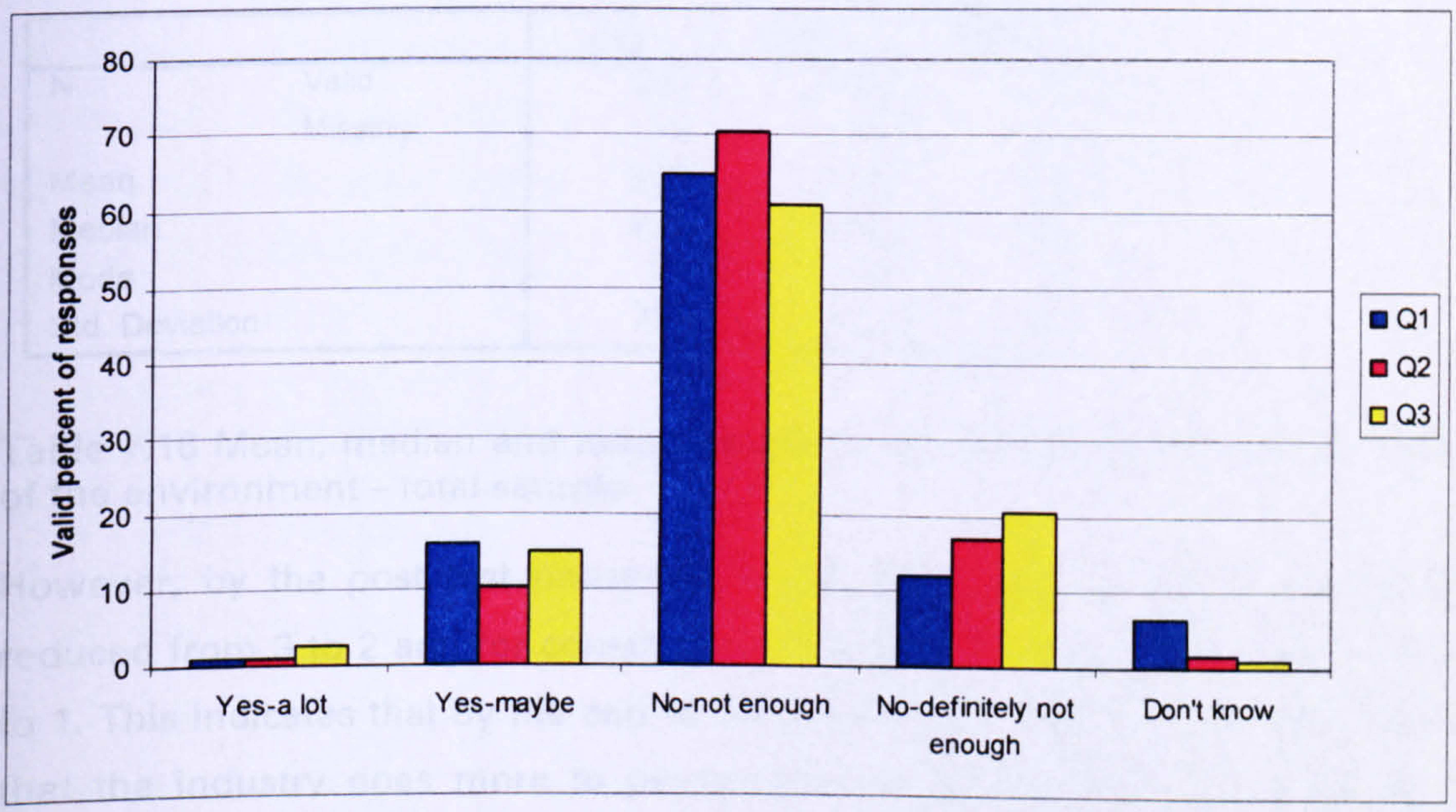


Chart 7.3 Student perceptions of whether the construction industry does enough to protect the environment

There was no statistically significant difference in responses by mode, age or programme of study in the pre, mid and post tests. The median and mode values were the same in the pre and mid test stages and the mean and standard deviation values were very similar as shown in tables 7.15 and 7.16.

Statistics

		Q15	Q15	Q15
N	Valid	41	39	37
	Missing	0	2	4
Mean		2.85	3.03	1.78
Median		3.00	3.00	2.00
Mode		3	3	1
Std. Deviation		.760	.584	.947

Table 7.15 Mean, median and mode values for perception of industry protection of the environment – construction management only

Statistics

		Q15	Q15	Q15
N	Valid	202	185	174
	Missing	16	33	44
Mean		3.05	3.08	1.97
Median		3.00	3.00	2.00
Mode		3	3	2
Std. Deviation		.777	.612	.873

Table 7.16 Mean, median and mode values for perception of industry protection of the environment – total sample

However, by the post test phase the modal value for the whole sample had reduced from 3 to 2 and for construction management only had reduced from 3 to 1. This indicates that by the end of the project the students generally believed that the industry does more to protect the environment than they did at the beginning of the project, and construction management especially so. This assumption was not supported to any extent by the supporting student statements, for example:

'Sustainable construction methods are an under valued part of any construction professionals role and its importance will only increase in the future'

'I don't believe that the construction industry will willingly take up the idea of sustainability as there is much greater risk when working with new, unknown technologies. It would take a change in government legislation to force them to take the idea seriously'

Unfortunately, there was nothing in the supporting statements that supported or explained this change in attitudes which was statistically significant between mid and post test stages with a significance level of .000.

There was a statistically significant difference in the responses at pre and mid test stage from students who claimed prior environmental interest as expected, with the responses from those who claimed an environmental interest indicating a more negative view of industry's protection of the environment, but by the post test stage this difference did not occur. The only possible explanation for this change is that students became more aware of greener systems and materials that are currently being developed and used by the industry. However it is unlikely that the students became aware of the level of use of these systems during the project.

The final set of questions relating to students awareness of current industry practice regarding sustainability aimed at identifying what factors the industry believes to be the most important in relation to the design and construction of buildings. Students were asked to rank the following from 1-6 with 1 being the most important:

- Low cost
- Short contract duration
- Aesthetically pleasing
- Good quality of work
- Good health and safety record
- Environmentally friendly

The results for the whole sample are shown in chart 7.4. with the figures given showing the mean result for each aspect, deducted from 6 which is the maximum ranking. This has enabled the data to be presented in a format that is easier to interpret.

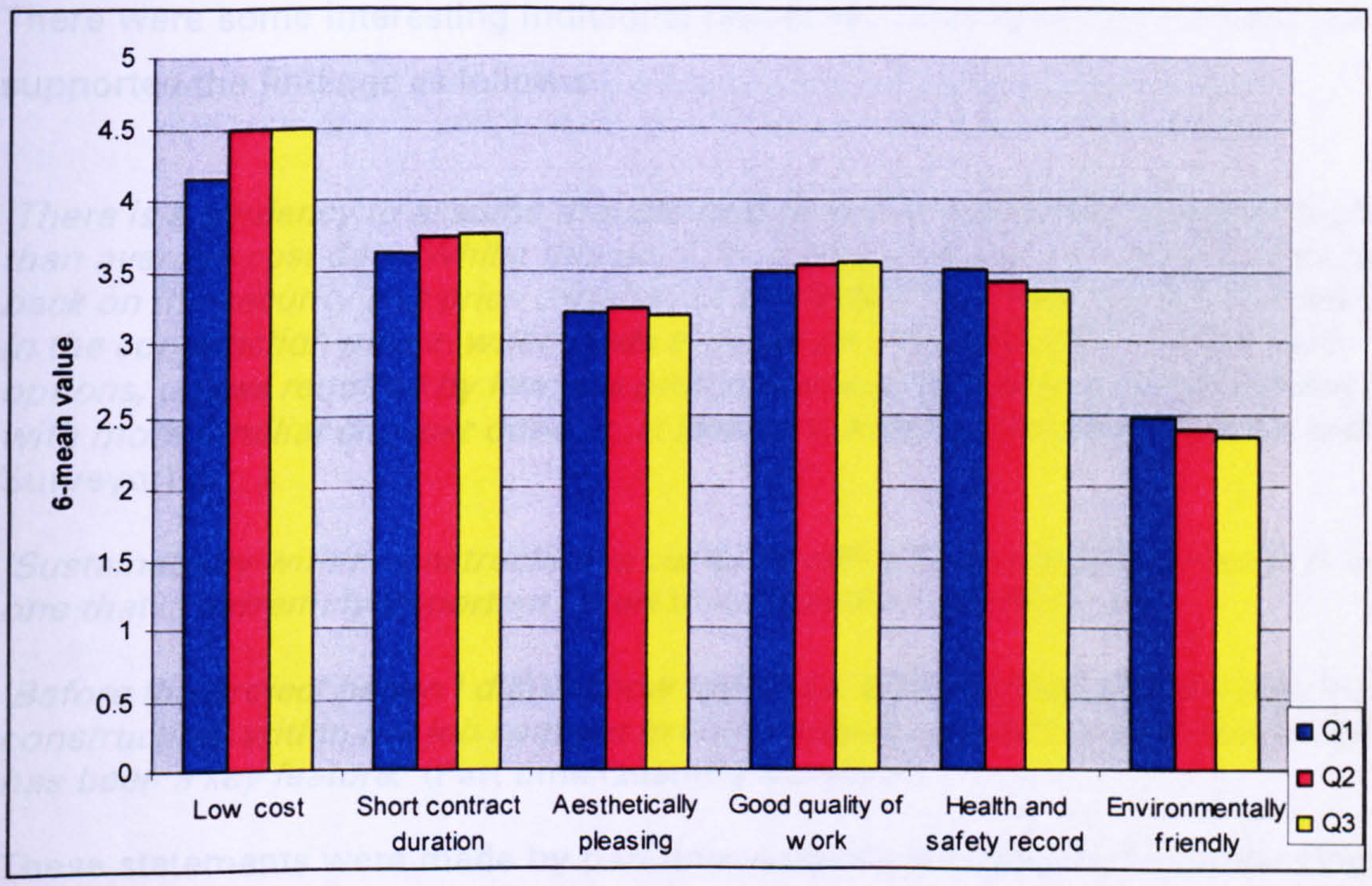


Chart 7.4 Student opinions of what the industry believes to be the most important issues in the construction of buildings- whole sample

The results illustrate that at the beginning of the project the students believed that the industry believes low cost is the most important aspect, and this belief increased as the project progressed. They also believed that the industry places environmental issues as the least important at the beginning of the project and even less so on completion. This contradicts the findings of the previous set of data, where the students seemed to believe that the industry was doing more to protect the environment than they had perceived at the beginning of the project. The rank order stayed the same at all three stages except that in the pre test stage quality of work was ranked at 4th place and health and safety in 3rd, but in the mid and post tests these positions were reversed.

An explanation for the increase in belief that the industry places low cost at the top of the list of priorities may have been the over representation by part time quantity surveying students in the group, who may have focussed a great deal of the discussions on costs and reducing costs. However there was no statistically significant difference in the responses by mode or programme (including construction management) at any of the stages. This indicates that the students believed the same at the beginning of the project and were not significantly influenced by students from other programmes.

There were some interesting individual responses relating to this element which supported the findings as follows:

'There is a tendency to assume that the best option is to prudently use the higher than average cost data. Whilst this persists, companies and clients naturally fall back on the security and price certainty of the technology they are familiar with. In the construction phase, when costs escalate on the project, the sustainable options, unless required by law, are probably one of the easiest things to replace with more familiar cheaper options, at least in the short term.'(Part time Quantity Surveyor)

'Sustainability within construction is currently still a new concept, however it is one that is extremely important.' (Part time Construction Manager)

'Before the project began I didn't know too much about sustainable buildings and construction, within my job I am yet to come across a project where sustainability has been a key feature.' (Part time Quantity Surveyor)

These statements were made by part time students who are currently working in the construction industry and illustrate that cost is deemed to be important, and sustainability is seen as a new concept that not many companies focus on.

This supports the findings of the literature review in chapter 2.3 that the industry has not adopted sustainable practices in the main as yet.

One comment that was worrying was:

*'This (sustainability) though may be a pipedream as the representatives from ***** only seemed interested in the financial savings rather than innovative sustainable designs'*

(***** was the construction company sponsoring the project and attending the presentations, who had stated that they placed sustainability very highly on their list of priorities.)

However on a more positive note, the following comment was made by a part time quantity surveying student:

'Whilst I have developed my knowledge of sustainability over the years through university modules, I have always found it difficult to apply this knowledge within the industry as every project I have ever worked on has always based its main objectives on cost, time and quality Following the completion of the integrated project I am extremely happy to announce that this Q.S is changing his ways'

Generally the data generated to illustrate any changes in awareness in the students from the pre to post test stages has been positive and students have claimed to be more aware, had become more aware of the impact of the work of the construction industry on the environment and aware of the precedence that the construction industry places on various facets of its work that supports the data generated in phases 1 and 2 and the literature review.

Individual student statements further illustrate these findings:

'The project has certainly raised my level of awareness of environmental issues, to the extent that I feel I can take on board certain aspects into my personal life'

'During the past week my awareness towards the sustainable impact of the construction industry has multiplied four-fold'

'I was not really aware of sustainability issues before the start of the project. However I now have a good understanding of sustainability. It is not just about the building and the materials used and where they are sourced from. It also includes the benefits for the community, sourcing, training, local labour and trades people, reducing waste in the construction process'

'So at the end of the project I now know that sustainability is not just about having grass on a roof or solar panels. It is also about simple things such as cutting down on wastage at the construction stage and recycling and re-using recyclable materials'.

However there is some contradiction in the findings in this section with the responses related to the issues of whether the construction industry does enough to protect the environment and the responses becoming more positive as the project progressed.

7.2.2.2 Knowledge

In order to assess student knowledge of sustainability they were asked to rank certain materials or systems as very damaging, damaging, averagely good or very good from an environmental perspective. The results at all three stages for the whole sample and the construction management students only are shown graphically in chart 7.5. The chart shows the mean responses and also the correct response for each of the five systems or materials.

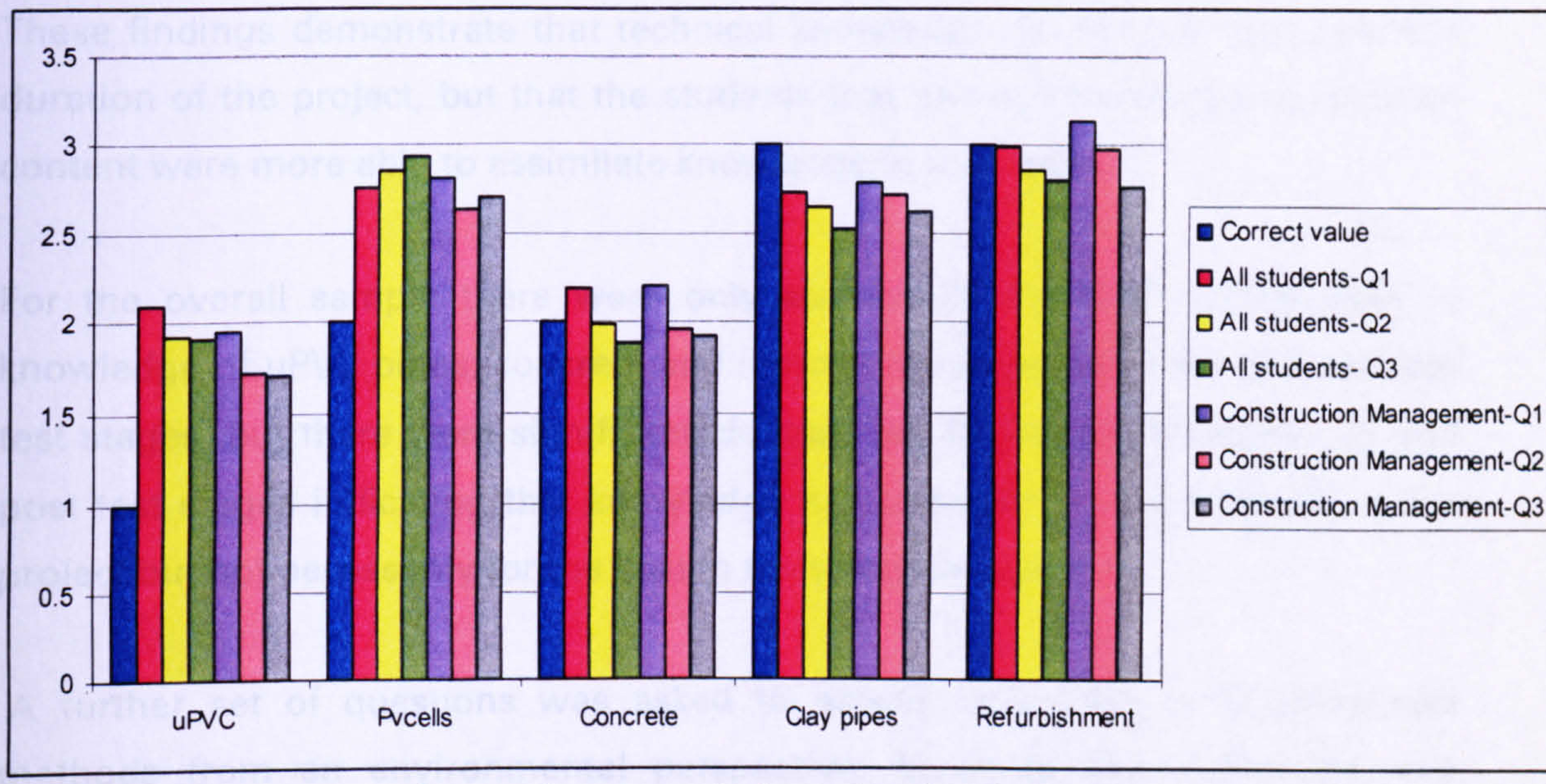


Chart 7.5 Mean results for student knowledge of technology

For uPVC the results improved during the project for the whole group and the construction management students only, and the construction management students were more knowledgeable at each stage than the whole group.

The results for concrete were very similar for both the whole group and the construction management group, and interestingly the mean response was nearer to the correct answer at the mid project stage.

For clay pipes the results showed that student knowledge for both the whole group and the construction management students went further from the correct value from the start of the project via the mid point to the end.

For refurbishment the mean for the whole sample was exactly at the correct level for the whole sample at the pre test phase but deviated away from it at the mid and post test stages.

An interesting trend for uPVC, concrete, clay drain pipes and refurbishment is that for both the whole group and the construction management students only, the trend was that they believed the systems and materials to be more damaging as the project progressed. However for PV cells the whole group believed them to be less damaging than they are as the project progressed whilst the construction management students believed them to be more damaging than they had believed at the start of the project.

These findings demonstrate that technical knowledge did not increase over the duration of the project, but that the students that had more technical curriculum content were more able to assimilate knowledge in this aspect.

For the overall sample there were only statistically significant differences in knowledge of uPVC pipes, concrete and refurbishment between the pre and mid test stages, but there were significant changes for all aspects between mid and post test stages indicating that knowledge had changed over the course of the project but not necessarily for the best in the technical aspect.

A further set of questions was asked to assess knowledge of procurement methods from an environmental perspective. Students were asked to rank procurement options as very good, good, average and not that good. An additional category of 'don't know' was included as it was envisaged that at least at the beginning of the project, the Real Estate Management students would be unaware of different procurement types.

The results for the total sample and the construction management students, plus the correct answer are shown in chart 7.6

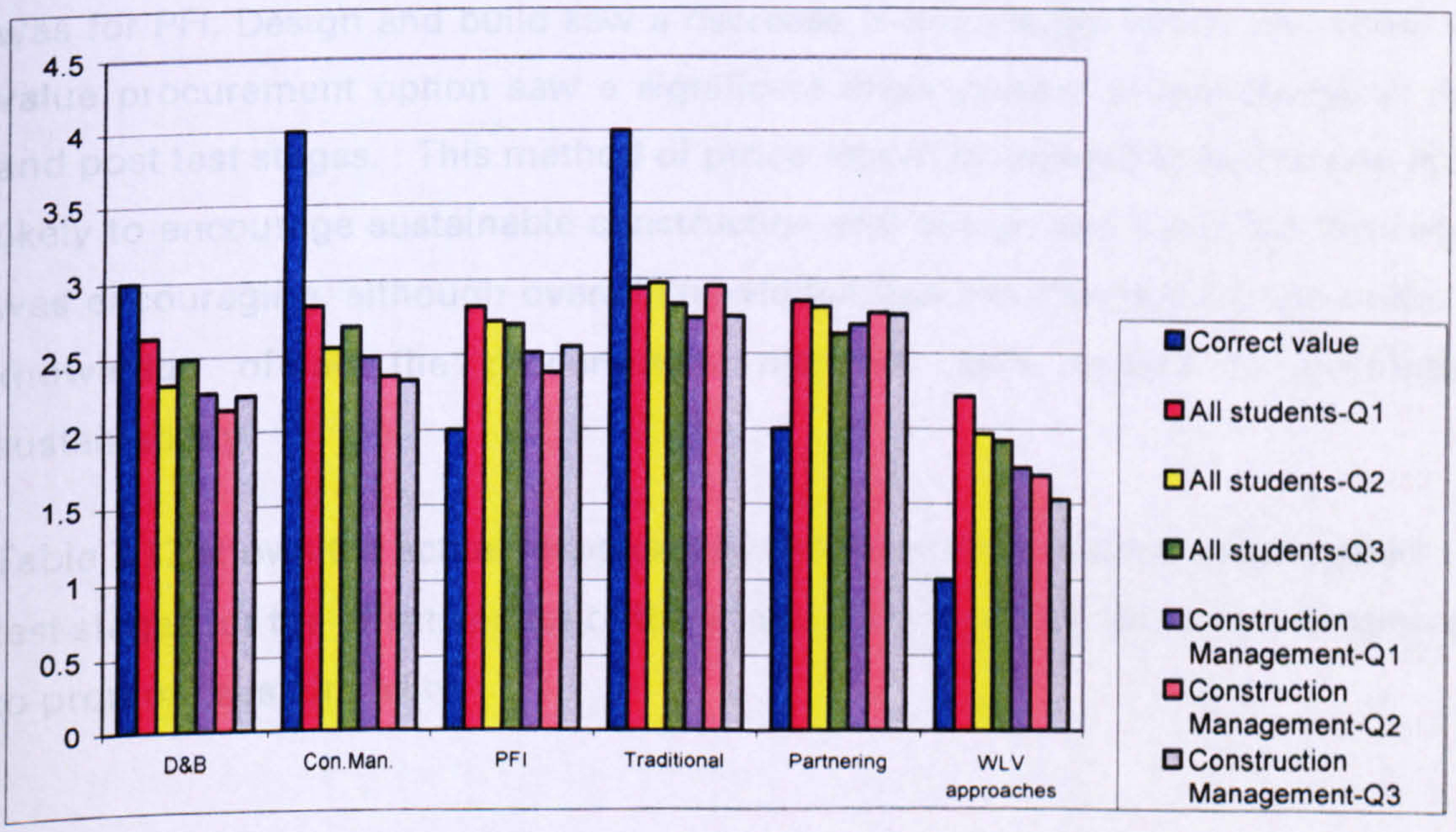


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Chart 7.6 Mean results for student knowledge of procurement

As can be seen, the mean response for design and build, construction management, and traditional procurement routes moved further away from the correct response as the project progressed. For PFI and partnering the responses for the total sample improved as the project progressed, but for the construction management group there was no significant change from the start to the completion of the project. For whole life value procurement methods, again the total sample mean moved nearer to the correct value over the duration of the project as did the construction management group, and this group's responses were nearer to the correct response at each stage of the project for this procurement method.

These results demonstrate that the knowledge of procurement methods that can encourage sustainable construction of the total sample improved during the project, but for the construction management group only knowledge actually reduced in all aspects except for the whole life value approach. For the total sample the changes in knowledge between the pre and mid stages for design and build, construction management and whole life values were significant, and between the mid and post test stages the changes in knowledge for design and build, traditional, partnering and whole life values were significant. Therefore the only category where there was no change in knowledge throughout the project was for PFI. Design and build saw a decrease in knowledge whilst the whole life value procurement option saw a significant improvement in knowledge at mid and post test stages. This method of procurement is deemed to be the one most likely to encourage sustainable construction and design and therefore this result was encouraging, although overall knowledge had not changed for the better in knowledge of all the procurement methods with regard to promoting sustainability.

Table 7.17 shows the actual responses by programme in the pre, mid and post test stages for the effectiveness of the whole life value approach of procurement to promote sustainability.

Programme * Q23_f Crosstabulation

Count

		Q23_f					Total
		very good	good	average	not that good	don't know	
Programme	CM	18	16	7	0	0	41
	QS	33	23	8	7	10	81
	BS	8	14	11	0	4	37
	REM	9	12	13	0	6	40
Total		68	65	39	7	20	199

Programme * Q23_f Crosstabulation

Count

		Q23_f					Total
		very good	good	average	not that good	don't know	
Programme	CM	21	12	4	1	1	39
	QS	33	24	15	2	3	77
	BS	10	10	7	2	3	32
	REM	11	15	8	1	1	36
Total		75	61	34	6	8	184

Programme * Q23_f Crosstabulation

Count

		Q23_f					Total
		very good	good	average	not that good	don't know	
Programme	CM	25	7	5	1	0	38
	QS	44	19	3	4	2	72
	BS	24	6	2	0	0	32
	REM	21	9	3	0	0	33
Total		114	41	13	5	2	175

Table 7.17 Responses to whole life value procurement approach by programme

A positive finding that is demonstrated in table 7.18 is that the number of students who stated 'don't know' had reduced from twenty to eight by the mid test stage and from eight to two at post test stage. The project therefore enabled eighteen students to feel knowledgeable enough to make a response by the end of the project. This set of figures demonstrates that students learnt that whole life value approaches to procurement are the most effective approaches to encourage sustainability. Whilst knowledge of other procurement was not improved, at least knowledge of the most important aspect did and statistically significantly.

A third set of questions was posed that asked the students to rank a number of factors that they thought would support the long term viability for the leasing and/or potential resale of a commercial building. There was no correct answer to this set of questions because they relate more to perception than fact. The mean results for the three stages are shown in chart 7.7. A 'don't know' category was also utilised for this set of questions as it was perceived that some students, mainly construction management and quantity surveying, would have little knowledge of these aspects at the start of the project. 'Very good' attracted a rating of 1 and therefore the lower the mean value, the better the students perceived the factor to be.

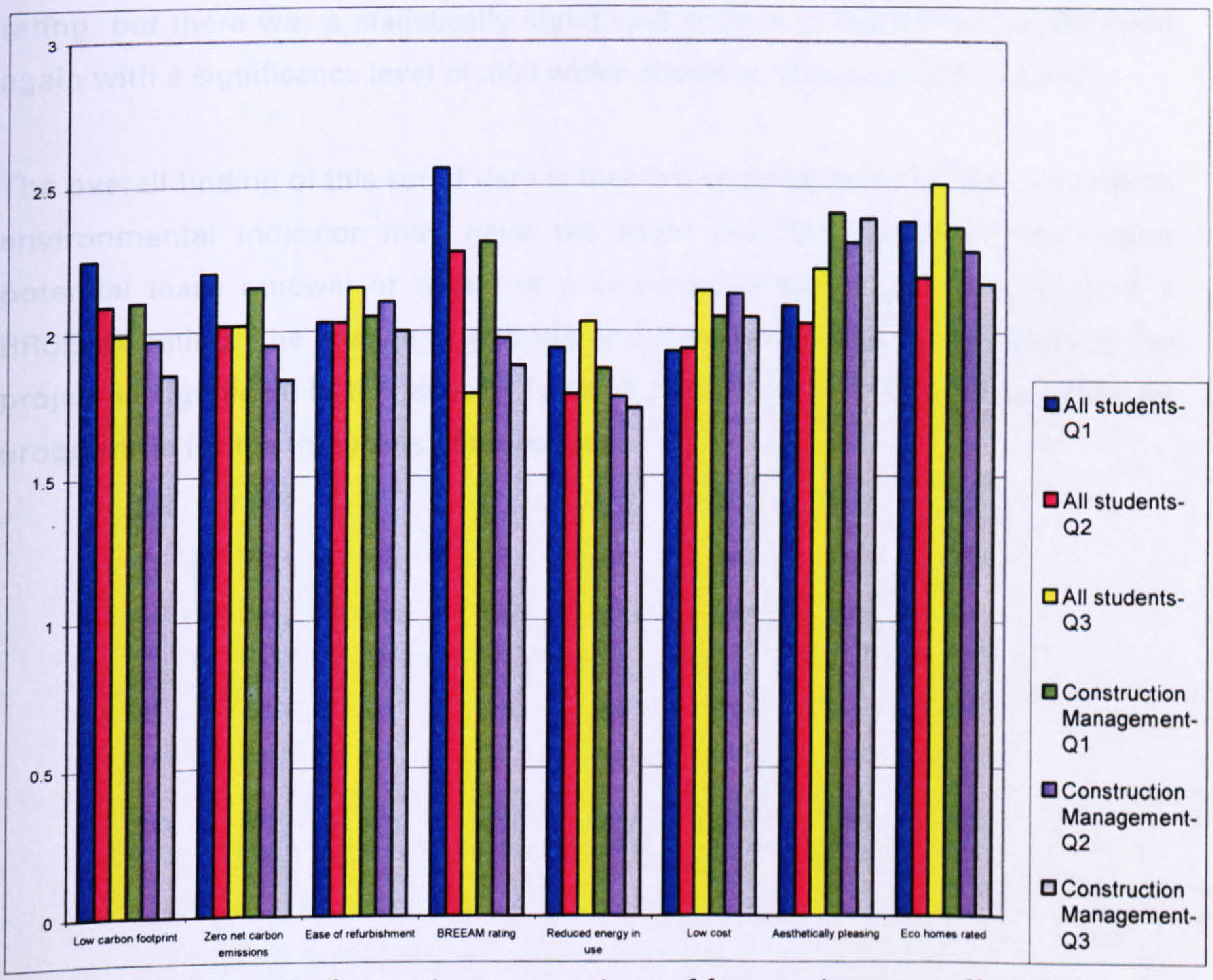

Chart 7.7 Mean results for student perceptions of factors that may affect the long term viability for the leasing and/or resale of commercial buildings

It can be seen from the chart that there was an increase in student perception that all the aspects that have a sustainability connection (except for eco home rating and reduced energy use) will have a positive impact of leasing/resale potential as the project progressed. This was mirrored by the construction management only group and they had also ranked eco home rating and reduced energy use as higher as the project progressed.

The differences in responses were statistically significantly different in a positive way for low carbon footprint, zero carbon emissions, reduced energy in use and eco home ratings between pre and mid test stages. However the greatest positive difference was for the BREEAM rating for which there was a significance level of .002.

Between mid and post test stages there were significantly different more negative responses for reduced energy use, aesthetically pleasing and eco homes rating, but there was a statistically significant change in responses for BREEAM again with a significance level of .000 which shows a very significant change.

The overall finding of this set of data is that the students perceptions as to which environmental indicator may have the most positive impact on the future potential lease renewal or resale of a commercial building in the future is a BREEAM rating. The change in attitude and knowledge over the duration of the project is significant in this aspect. Table 7.18 shows the results programme by programme for the three sets of responses.

Programme * Q22_d Crosstabulation

Count

		Q22_d					Total
		Very good	Good	Average	Not that good	Don't know	
Programme	CM	8	16	15	1	1	41
	QS	14	24	18	6	17	79
	BS	8	12	12	1	5	38
	REM	12	13	10	2	3	40
Total		42	65	55	10	26	198

Programme * Q22_d Crosstabulation

Count

		Q22_d					Total
		very good	good	average	not that good	don't know	
Programme	CM	11	19	8	1	0	39
	QS	18	27	20	2	8	75
	BS	3	14	13	1	0	31
	REM	11	13	8	1	3	36
Total		43	73	49	5	11	181

Programme * Q22_d Crosstabulation

Count

		Q22_d					Total
		very good	good	average	not that good	don't know	
Programme	CM	18	14	4	2	0	38
	QS	29	32	10	0	1	72
	BS	11	14	5	1	0	31
	REM	15	15	2	0	1	33
Total		73	75	21	3	2	174

Table 7.18 Responses to BREEAM qualification impact on leasing/resale of a commercial building by programme

The responses are encouraging and the reduction of twenty six don't know responses in the pre test to eleven in the mid test and then to two in the post test for BREEAM qualification ratings indicates that there was a significant amount of knowledge obtained in this aspect over the duration of the project.

As one student commented in their individual submission:

'I have also developed a good understanding of SAP requirements and BREEAM assessments. I was not aware of any of these before the start of the project.'

The construction management students (except one) felt confident enough to give a response to this aspect and this maybe because they undertake environmental science as a subject in level 1 of the existing programme. However any direct entry to level 2 students would not have done this and may not have studied environmental science on an earlier programme. This could account for the improvement in knowledge for this group of students throughout the project.

The questions used to assess knowledge have demonstrated that technical knowledge did not improve significantly, knowledge of one specific procurement method (whole life value technique) did improve but knowledge of other procurement methods did not and knowledge of sustainability factors that may influence future lease renewals/resale did improve, especially knowledge of BREEAM.

Quotes made by the students in the individual submissions to support these findings included:

'From my disciplinary outlook the effects associated with costs were the most notable. At first glance sustainable construction seems an expensive operation and from a quantity surveyors perspective the only agreeable solution is the use of reclaimed material, yet often over the lifecycle of the building the initial high installation costs are eventually outweighed in terms of energy savings, etc'

'My worry was that these products would cost a lot initially and would mean that buildings would cost more to build, however many of these products save money over longer periods of time and will save the end user money'

These comments demonstrate that the students had learnt that initial cost savings at the construction phase could be outweighed by savings made over the life of the building by using higher initial cost systems at the outset.

'Being sustainable in construction does not only apply to using materials and methods to have less impact but also having consideration towards lean construction management and applying methods of management in order to achieve goals efficiently.'

This student has developed a knowledge of sustainable construction from a management perspective rather than it being just a technical issue.

'The group project did further my knowledge of sustainable construction, as we had to determine the practicality of implementing the various technologies'

'What changed during the process of the week though is that I learnt more about the application of these sustainable solutions into projects and the effects of these solutions of cost in the short term as well as the long term'

These student comments support the notion that application through project work is a good way to learn, and to learn in a practical application of theory has enhanced learning of theories.

'On reflection the process has enhanced my knowledge more than I thought it would and highlighted the lack of depth to my previous learning.
I've always been aware that the overriding environmentally geared drivers in the Industry are to reduce carbon emissions and other pollutants (directly / indirectly), as well as to reduce waste. This project however, has brought to my attention government / industry led initiatives / policies which have been created to tackle these issues'.

This student had developed a more holistic appreciation of the concept of sustainability and also supports the notion that application via projects improves the depth of knowledge.

A student that had claimed a prior environmental interest and is undertaking an environmentally focussed dissertation stated:

'I found that over the course of the week I had not improved my knowledge of the subject area but I had reassured myself of different areas surrounding the topic. This helped me to really value other people's opinions, but feel that people's general knowledge of the area could be improved in a short amount of time and this is ideally what is needed over all areas of the profession'

This student supports the idea that small interventions can be very useful in the attainment of knowledge. However some prior knowledge of the subjects involved is required to make the best of the intervention.

The students were asked if they believed the process of Personal Development Planning (PDP), which was incorporated into the project and has been part of their programme of study since level 1, had helped to improve skills and knowledge. Their perceptions as to whether it had, changed over the course of the project. In the pre test responses the modal value was 'moderately', and in the mid and post test stages the modal values were 'yes-but not a lot'

The mean value at pre stage was 2.56, at the mid stage was 2.37 and at the post test stage was 2.26. The standard deviations at each stage were very similar. A value of 1 related to 'yes-a lot' and the decrease in mean values shows a more positive perception of PDP as the project progressed. The Wilcoxon signed rank tests confirmed that these changes were significant for the whole sample with significance levels of .022 between responses at the pre and mid stages of the project and .045 between the mid and post tests.

There was no statistically significant difference in the responses by programme of study or prior environmental interest at any of the three stages, by age in the pre test or by mode in the pre and post tests. However at the mid and post test stages there was a statistically significant difference by age which was more marked at the post test stage with a significance level of .004 as opposed to a significance level of .019 at the mid stage. However the levels of association being weak with Cramer's V values of .239 and .310 consecutively. The results showed that the under 25 students ranked the impact of PDP on learning as significantly more then the over 25 students.

At the mid test there was a statistically significant difference by mode of study with a significance level of .005 but the level of association was also low with a Cramer's V value of 0.271. Full time students ranked the impact of PDP on learning far higher than part time and sandwich students.

These results indicate that the recommendation of 'The Future Paradigm for Sustainable Construction Curriculum Design Model' that there needs to be a mechanism embedded in the curriculum that will enable the students to reflect on preconceived beliefs and undertake a critical analysis of their attitudes to the environment, is correct especially for younger full time students.

7.2.2.3 Attitudes

Students were asked at the pre test stage whether their attitude towards the environment had changed since starting their programme of study. The modal response was, 'yes- a lot' and the mean result was 2.53 which indicates a result between 'yes- a lot' and 'moderately'. The students were then asked whether their attitude to the environment had changed since the start of the project and the modal response was 'moderately' with a mean of 2.85 which is between 'yes- a lot' and 'moderately' but much closer to moderately. The students were asked the same question again at the post test stage and the modal response was 'yes-a lot' with a mean of 2.39 which is closer to the 'yes-a lot' rank than the 'moderately' rank.

This indicates that the previous study undertaken in the student's programme of study had changed attitudes and by the end of the project the changes were significant. The greatest change in responses came between the mid and post test stages with a .000 significance level calculated using the Wilcoxon signed ranks test.

There were statistically significant responses by mode, programme of study and level of prior environmental interest but by age at the pre test stage, no statistically significant difference by mode, programme, age or prior environmental interest at the mid stage and no difference by mode, programme or prior environmental interest at the post stage, but there were by age.

At the pre test stage full time students stated that their attitudes to the environment had changed since starting the programme far more than part time and sandwich students whilst construction management and building surveying students claimed more of a change than real estate management and quantity surveying students. As expected the students who claimed to have a prior environmental interest claimed to have changed attitudes much more than those with no prior interest. At the post test stage students aged under 25 claimed much more of a change in attitude than those aged over 25. However the level of association was low in each case with Cramer's V values of less than 0.3.

At the post test stage the under 25 students claimed to have significant changes in attitude with a significance level of .006 but again the level of association was low as illustrated in table 7.19.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.235			.006
	Cramer's V	.235			.006
Ordinal by Ordinal	Gamma	.304	.133	2.089	.037
N of Valid Cases		187			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Table 7.19 Levels of association for differences by age for changes to attitudes

These results indicate that students attitudes had changed but do not explain the phenomenon. However quotes from the individual student competency audits are used to illustrate the reasons for changes in attitudes and the extent of changes.

'Before the project I was aware of the environment but my attitude has changed a lot towards it now. I did not realise that construction has such an effect on the environment'

'The process has given me a clearer understanding of certain issues and has led to a change in attitude. I now fully appreciate the inextricable link between the factors that lead to pollution and global warming and now consider it as one issue rather than two.'

'Thanks to the project my outlook on the environment has dramatically been altered. I have chosen a career in an industry, which at present is destroying our natural habitat and environment and this needn't be the case!!!'

'From the work we have carried out on sustainable construction my knowledge on the subject has certainly improved vastly but also my attitude towards it.'

These responses indicate that attitudes have changed because knowledge has increased. The students did not realise the extent of damage that construction work and buildings cause to the environment, the project allowed them to attain that knowledge and this in turn has changed attitudes.

Where attitudes have not changed there are still some positive comments from students, for example:

'My attitude towards environmental issues in the construction industry has not changed due to this project. I have always had strong beliefs in these types of issues and have researched them in my work place as possible forms of construction.'

This student did not have a change in attitude but obviously felt strongly about the issue of environmental damage caused by construction work before undertaking the project.

The students were asked whether they personally (regardless of any other opinion) believed that the issue of the environment is important. The modal response at each of the three stages was 'yes-a lot' but the mean of the responses moved from 1.95 at the pre stage to 1.90 at the post test stage which is closer to the 'yes-a very great deal' rank. This change in opinion occurred between the mid and post test stages after a period of reflection and is a positive outcome. The change was statistically significant with a significance level of .000 between both the pre and post test, and mid and post test stages. There were no statistically significant differences in opinion between responses by age, by programme, by mode of study or by level of prior environmental interest at any of the stages.

Comments from students that support these findings included:

'It (the project) also helped me to see how sustainable construction is a positive approach to the environment rather than my old views of it just being a waste of money'

And

'After this week I have been reassured of the importance behind these issues and also been made more aware of the changes I can make personally'

Students were then asked to rank the following from 1-6 with 1 being the most important factor that they considered to be in relation to the construction of buildings.

- Low cost
- Short contract duration
- Aesthetically pleasing
- Good quality of work
- Environmentally friendly

The mean results were deducted from six to allow a chart to be produced that represents and increase in ranking by an increase in bar height. The results are given in chart 7.8

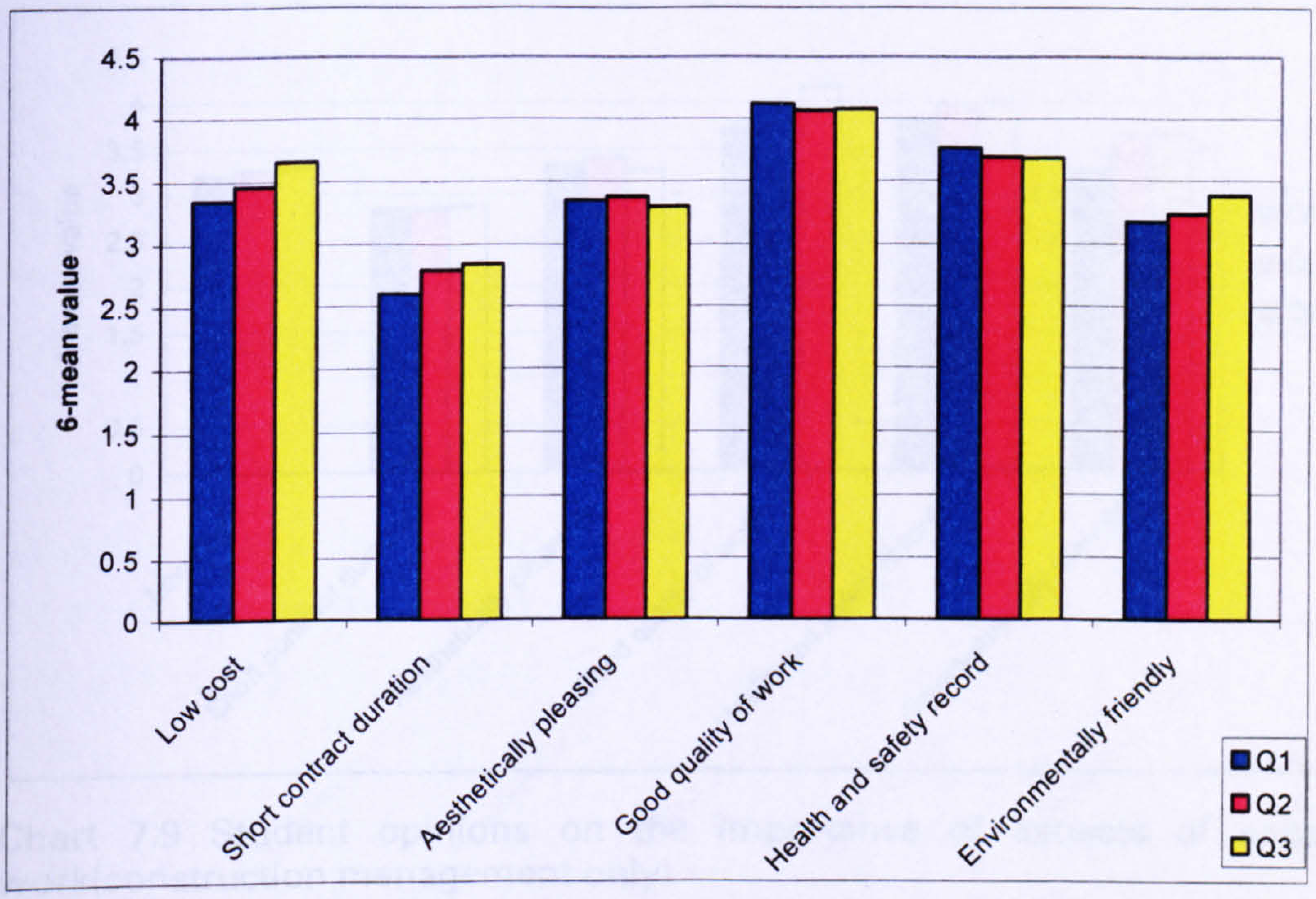

Chart 7.8 Student opinions on the importance of aspects of construction work

The results illustrate that for the whole sample low cost, short contract duration and environmentally friendliness were deemed to be more important over the duration of the project, whilst aesthetically pleasing, quality of work and health and safety were deemed to be less important, but the changes were not extensive. The rankings at the three phases are shown in table 7.20.

Stage 1	**Stage 2**	**Stage 3**
1. Good Quality of Work 2. Good Health and Safety Record 3 & 4. Low cost= Aesthetically pleasing 5.Environmentally friendly 6. Short duration	1. Good Quality of Work 2. Good Health and Safety Record 3 Low cost 4.Aesthetically pleasing 5.Environmentally friendly 6. Short duration	1. Good Quality of Work 2. Good Health and Safety Record 3 Low cost 4.Environmentally friendly 5.Aesthetically pleasing 6. Short duration

Table 7.20 Rankings for aspects of construction work deemed to be personally important

From this ranking table it can be observed that the only change in ranking is that environmentally friendly had moved up a rank by stage 3. The results for the construction management students only are given in chart 7.9.

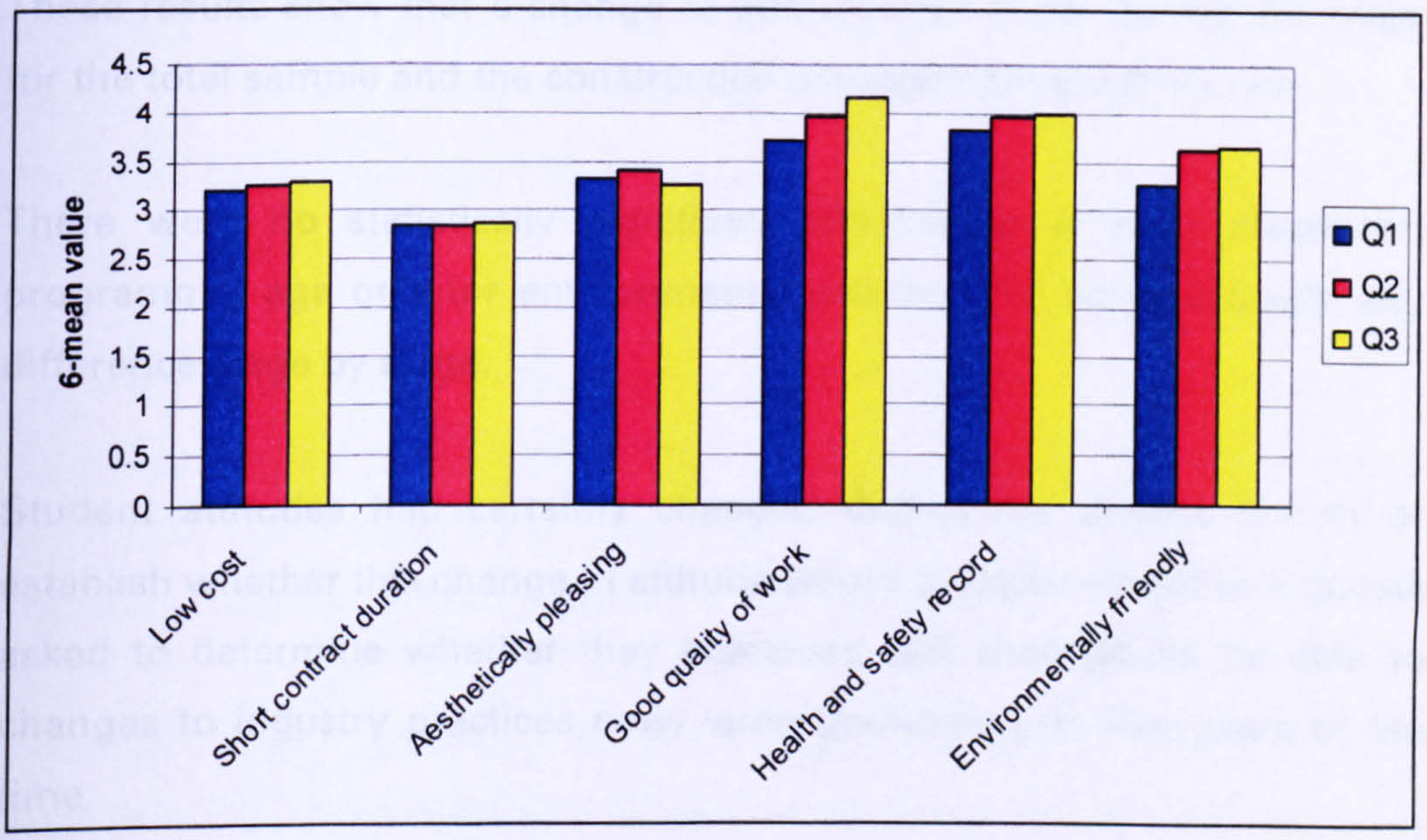

Chart 7.9 Student opinions on the importance of aspects of construction work(construction management only)

These results are very similar to those for the total sample with an increase in the importance of low cost, short contract duration and environmental friendliness whilst aesthetically pleasing was deemed to be less important. However the construction management students ranked health and safety and quality of work as more important as the project progressed, which was different from the main group.

The rankings for the construction management students is given in table 7.21:

Stage 1	**Stage 2**	**Stage 3**
1. Good Health and Safety Record 2. Good Quality of Work 3. Aesthetically pleasing 4.Environmentally friendly 5. Low cost 6. Short duration	1. and 2. Good Health and Safety Record = Good Quality of Work 3.Environmentally friendly 4. Aesthetically pleasing 5. Low cost 6. Short duration	1. Good Quality of Work 2. Good Health and Safety Record 3.Environmentally friendly 4.Low cost 5. Aesthetically pleasing 6. Short duration

Table 7.21 Rankings for aspects of construction work deemed to be personally important (construction management students only

The main differences between the total sample and the construction management students is that they placed more emphasis on health and safety and they consistently ranked environmental friendliness a rank higher than the total sample.

These results show that a change of attitudes did occur during the project both for the total sample and the construction management students only.

There were no statistically significant differences at each stage by mode, programme, age or prior environmental interest and no statistically significant difference stage by stage.

Student attitudes had certainly changed during the project but in order to establish whether this change in attitude would change behaviour a question was asked to determine whether they perceived that they would be able to make changes to industry practices now, upon graduation, in five years or ten years time.

The modal response to this question was 'in five years time' at all three stages. Between the pre and post stages there was a statistically significant difference in the responses with more students stating 'in ten years' which affected the mean and there was no statistically significant difference between the responses from the mid stage to the post stage. This indicates that the students realised that the industry needs to change significantly and the drivers for this change need to be at a senior level in organisations. The shift from five years to ten years indicates that the students believe that they will not achieve the seniority required to make changes until they have ten years of experience. This finding is supported and partially explained by the very mature statement by one student:

'In context of my chosen career; my attitude towards environmental issues has changed since taking part in the integrated project; as prior to the project I viewed the damaging effects that the construction industry has upon the environment, which are considered vast in comparison to other industries, as unfortunate but unavoidable. However, as a result of what I have learned from the project and from listening to the ideas that the other groups put forward in their presentations, I now believe that it is possible, by employing some lateral thinking and by employing some innovative ideas, to at least partially decrease the damaging effects caused by the construction industry upon the environment and improve the negative reputation that the construction industry has in this area. But this will take time and I am not at a senior enough level yet to be able to make changes.'

There were no statistically significant differences in the responses by programme of study or level of prior environmental interest at any of the three stages. At all three stages though there were significantly different responses by mode of study with part time and sandwich students probably being more realistic and stating that their ability to make differences to industry practices will take longer than full time students. However the levels of association were weak with Cramer's v values of 0.35, 0.309 and 0.327 consecutively.

There was also a statistically significant difference in responses by age at the pre test stage with the under 25 students again being more optimistic about timing of the impact on industry practices than the over 25s. However the level of association was weak with a Cramer's V value of 0.28.

Questions were asked to determine whether students believed they had a responsibility as construction professionals to inform the general public and clients about the effects of construction work on the environment. These questions aimed at determining whether the changes in attitude would change behaviour.

Chart 7.10 illustrates the responses by mean at the three stages of the project. The lower the value, the more importance is placed by students on informing clients and the general public.

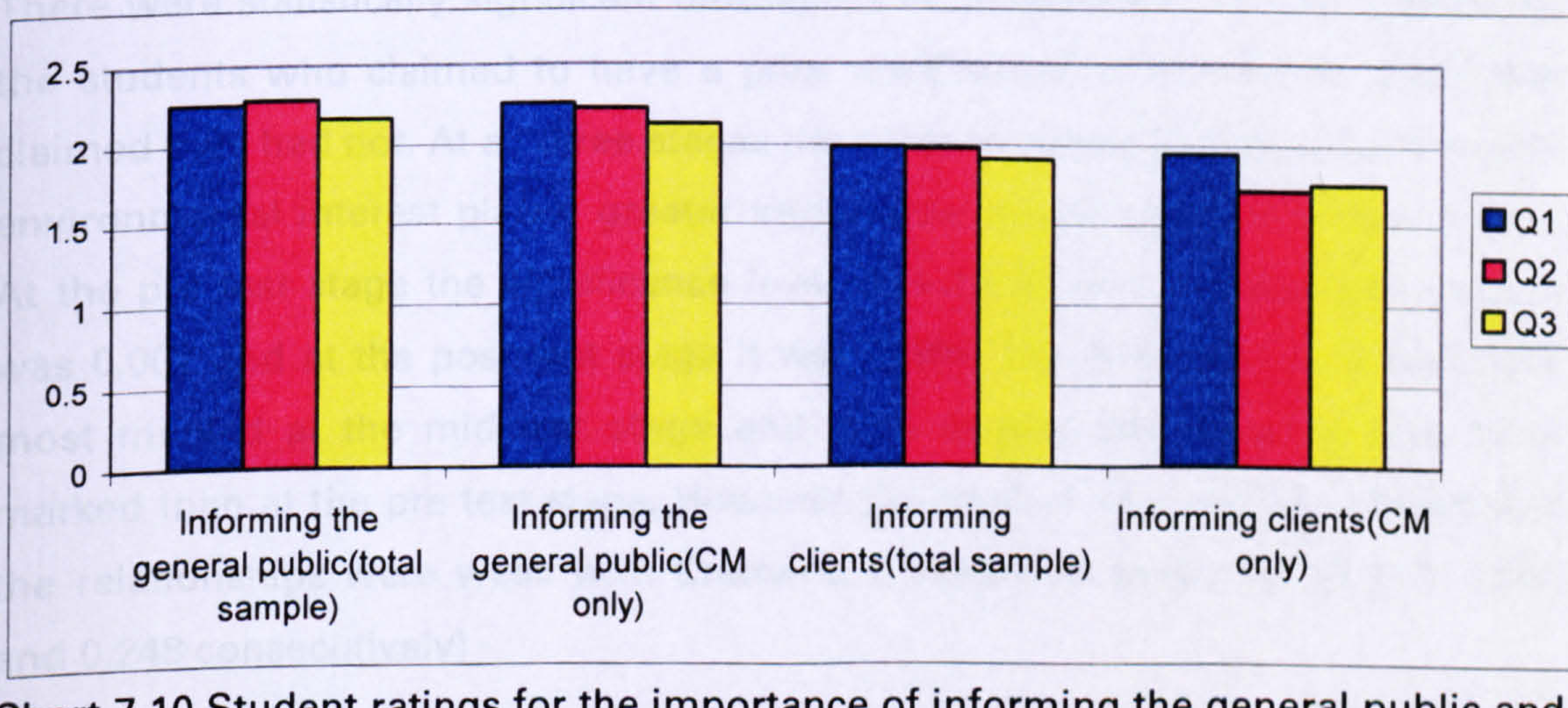

Chart 7.10 Student ratings for the importance of informing the general public and clients about the effects of construction work on the environment

The results demonstrate that both the total sample and the construction management student groups believe that as professionals it is more important to inform clients than the general public about the impact of construction work on the environment. It can also be seen that the level of importance placed on informing both the clients and the general public increased as the project progressed. For informing the general public between the mid and post test stages these changes were significant with a significance levels of .000 generated by the Wilcoxon signed ranks test. The level of importance placed on advising the client did not change significantly between the pre and mid test and the mid and post test stages but there was a statistically significant change between the pre and post test stages with a significance level of .030.

There was no statistically significant difference in response by mode at any of the stages. There were statistically significant differences in responses by age at pre test stage for advising clients and at the mid test stage for advising the general public. At the pre test stage the over 25 students believed it was much more important to advise clients but this difference changed and the under 25 students believed it to be much more important as the project progressed. At the mid test stage the over 25 students believed it to be more important to advise the general public than the under 25 students, but the significance level was relatively high (.036) and therefore the difference in response, although statistically significant, is not great and this is confirmed due to the value of 0.189 being generated for the Cramer's V value.

There were statistically significant differences in responses at all three stages by the students who claimed to have a prior environmental interest to those that claimed they had not. At all three stages the students who claimed to have a prior environmental interest placed greater importance on the need to advise clients. At the pre test stage the significance level was 0.015, and the mid test stage it was 0.002 and at the post test stage it was 0.004. The difference was therefore most marked at the mid test stage and even at post test stage it was more marked than at the pre test stage. However the level of association showed that the relationships were weak with Cramer's V values all under 0.3 (0.212, 0.263 and 0.248 consecutively)

The results showed that potential behaviour with regard to informing clients and the general public was deemed to be more important after the completion of the project than before the project started. Therefore it can be assumed that the previously established changed attitudes could inform future behaviour.

Students recognised the need to inform the general public, but that there is a wider responsibility to do this rather than it being just the responsibility of construction and property professionals. This statement is supported by the following student quotes:

'However I also believe that the knowledge of such technologies is not enough, and there is a need for a change in public opinions if this or any industry is willing to change'.

'The government at present doing a lot to change people attitude on environment but it is essential for us as professionals to lead the way.'

However there is an awareness that they are ideally placed to inform clients and educate the professionals who could have the most impact. This statement is supported by the following student quotes:

'I will continue to push for environmental systems in my work place but as a quantity surveyor does not have the power to implement these systems, all I can do is educate clients and other professionals as to the way forward in environmentally friendly sustainable construction'.

'I intend to advise these clients of the benefits of sustainable properties and urge them to use or purchase them rather than traditional properties'.

As a final test to establish whether attitudes had changed enough to change potential behaviour, the students were asked whether when buying their own house they would pay more if it included more environmentally friendly products or systems. The results of the mean responses are given in chart 7.11

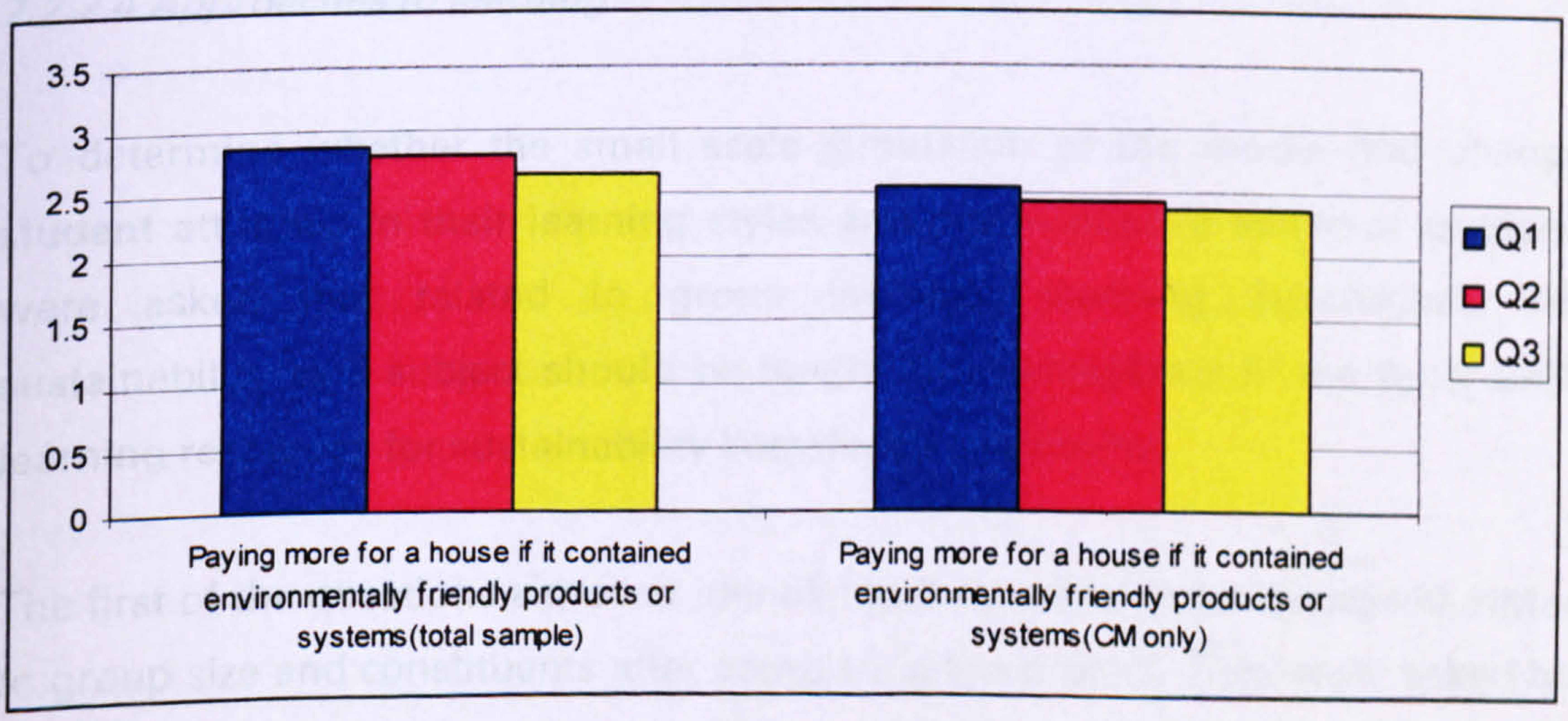

Chart 7.11 Means of student responses for whether they would pay more for a house if it included environmentally friendly systems or products.

A reduction in mean indicates more inclination to pay more for a house if it contained environmentally friendly products and the chart illustrates that both for the total sample and construction management only, the inclination to pay more increased as the project progressed, with the construction management students more inclined to pay more at each stage than the total sample. The change between the pre and mid test stages were not statistically significantly different but between the mid test stage and the post test stage they were different with a significance level of .000, illustrating that the change was quite significant.

There were no statistically significant differences in responses by mode of study, programme, age or prior environmental interest at any of the three stages.

These results indicate that potential behaviour could change as a result of changing attitudes. Some students identified that they may not be able to change industry practices significantly but that they could change their own behaviour, as one student quoted:

'Now, I can't change the construction industry's approach overnight but I can certainly change my habits!'

This is only an indication of future potential behaviour, the real test would be whether the students actually would or do pay more for a more environmentally friendly dwelling. However the results are still positive.

7.2.2.4 Approaches to learning

To determine whether the small scale simulation of the model had changed student attitudes to their learning styles and preferences, a series of questions were asked that related to group learning, teaching approaches, how sustainability as a subject should be taught and perceptions of the most useful learning resources for sustainability knowledge acquisition.

The first of the questions aimed at identifying if students had a change in attitude to group size and constituents after completing the project. They were asked how effective they believed the following group based scenarios are as learning tools.

- Small group, single disciplinary
- Small group, inter disciplinary

- Large group, single disciplinary
- Large group, inter disciplinary

The results are illustrated in chart 7.12 and a reduction in mean equates to an increase in perception of effectiveness.

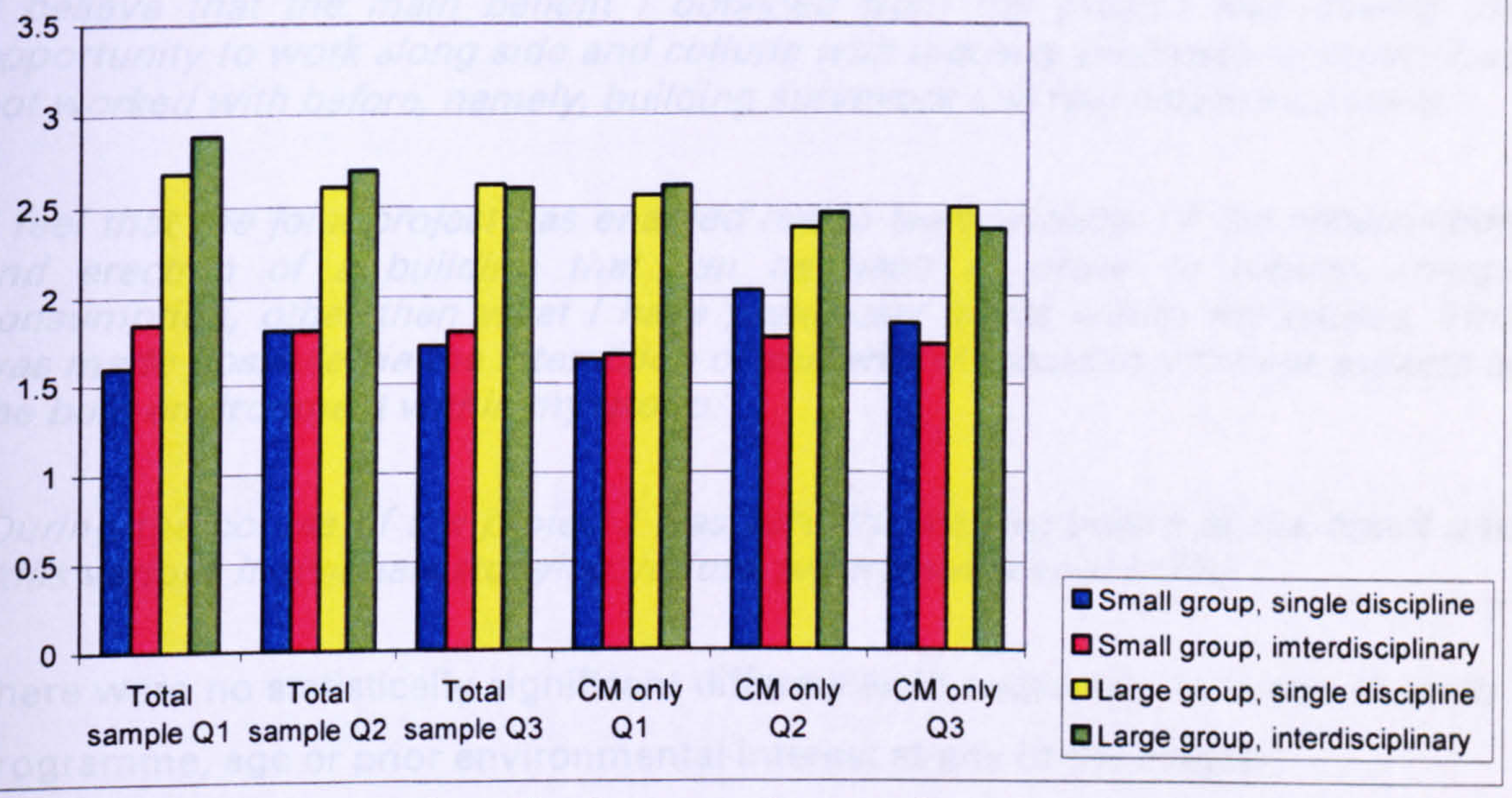

Chart 7.12 Mean values for effectiveness of group based scenarios

The project was undertaken with the students placed in large, interdisciplinary groups and the perception of the effectiveness of this approach increased over the duration of the project for both the total sample and the construction management students. The only statistically significant difference in rating between the pre test and mid test was for large group interdisciplinary groups and there was also a statistically significant difference between the mid and post tests. However, large groups were deemed to be less effective than small groups at each stage.

The total sample results indicate that the usefulness of interdisciplinary groups as opposed to single disciplinary was deemed to be more effective at the mid test stage, but then reverted back to being less effective at the post test stage. However for the construction management group the trend went the opposite way. By the post test stage the total sample believed that single disciplinary groups were the most effective, whilst the construction management students believed that interdisciplinary projects were more effective for them. Between the mid and post tests there was a statistically significant difference in the responses for small group interdisciplinary, which supports the statement that students perceptions of the effectiveness of interdisciplinary projects increased over the course of the project. This is further supported by the following student comments:

'I believe that the main benefit I obtained from the project was having the opportunity to work along side and collude with industry professionals that I had not worked with before, namely, building surveyors and real estate managers.'

'I feel that the joint project has enabled me to learn aspects of the construction and erection of a building that can be used in order to reduce energy consumption, other than what I have previously learnt within my course. This was made possible via the interaction of students involved in different aspects of the built environment within my group.'

'During the course of the project I was actually very surprised at the talent and skills various individuals studying various programmes could offer'

There were no statistically significant differences in responses by mode of study, programme, age or prior environmental interest at any of the stages.

Before the project started, many students expressed concerns about working in groups especially at final level. This was due to previous experiences of group working where some members of the group had not participated as fully as others. However during the project they ranked group working as a preferred learning approach more highly as the project progressed. The mean results for the preference for group based activities reduced from 3.23 at the pre test stage to 2.96 at the mid point stage and then further to 2.92 at the post test stage and the changes between pre and mid test and mid and post test were both determined to be statistically significant using the wilcoxon signed ranks test with significance levels of .009 and .000 consecutively.

At the pre and mid test stages there were statistically significant differences in the responses by mode of study, but the differences are difficult to interpret because more part time students placed group learning as the best learning tool, but more of them also ranked it as the worst at both stages. At the post test stage there was no statistically significant difference in responses by mode, indicating that the responses were more uniform across the different modes of study by this stage.

There were no statistically significant differences in response by programme, age or prior environmental interest. The results demonstrate that the students perceived more benefit and effectiveness of group based learning at the end of the project than they did at the start.

The data generated did not indicate any improvement in the perception of the effectiveness of working on real life projects, in fact the data suggested that at the end of the project students believed this to be a less effective approach than they did at the start. However some students commented that they found this to be most useful:

'My experience to date has been very theoretical and the use of a real life case study has made me recognise the need to tackle environmental issues from a more realistic standpoint.'

*'The involvement of ******* Construction in providing an actual project and then observing and discussing the presentations was invaluable in making the project real and relevant'*

The students were asked how they thought sustainability as a subject should be taught, ranking various scenarios 1-5 with 1 being the preferred option. The results are illustrated in chart 7.13. They were asked this to ascertain how they thought that they would have been better prepared to undertake the project via previous study.

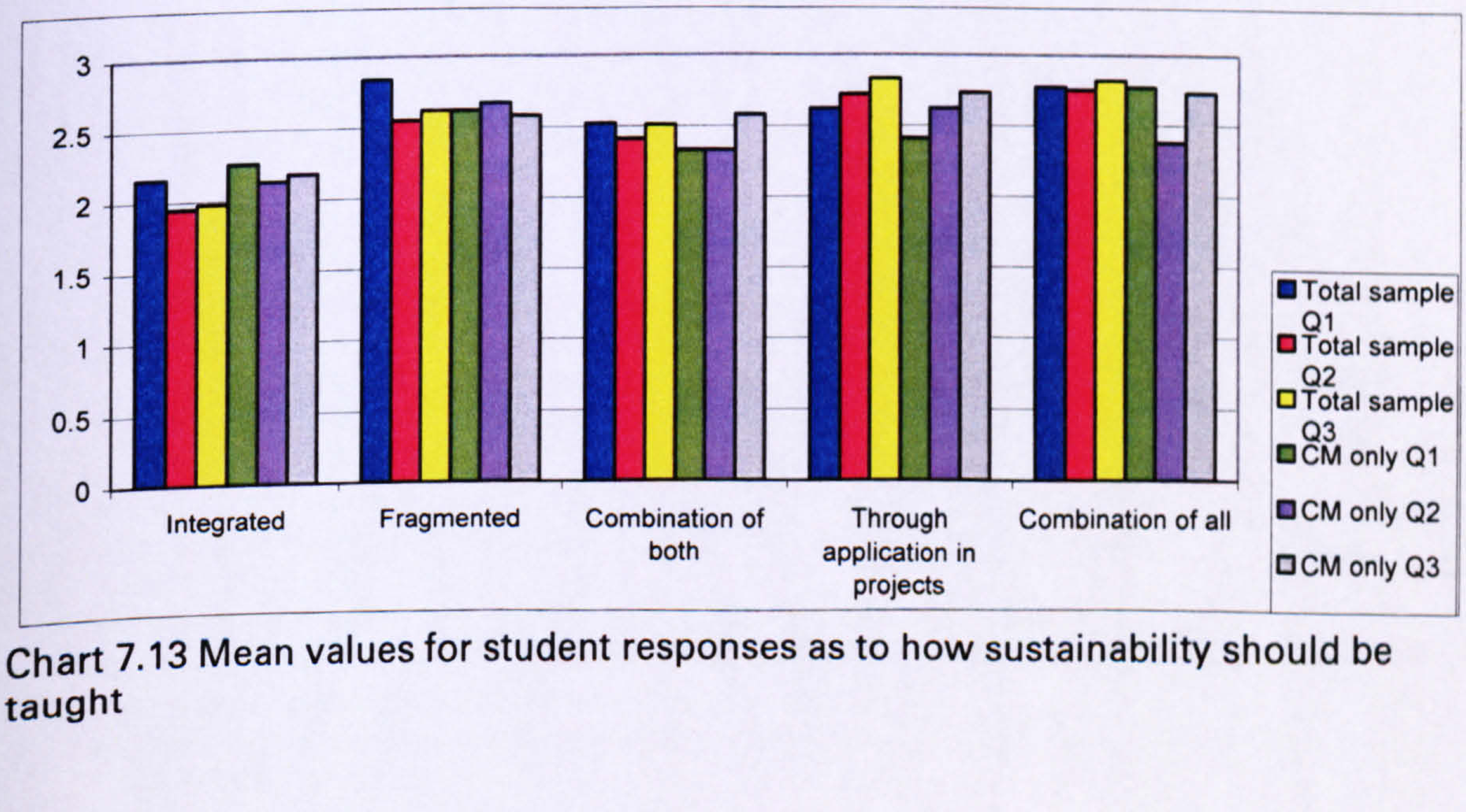

Chart 7.13 Mean values for student responses as to how sustainability should be taught

The initial finding of these results is that integration is deemed to be the preferred option for the teaching of sustainability followed by a combination of integration and fragmentation. Integration increases in popularity from the pre to post test stages, as does fragmentation for both the total sample and the construction management group. Teaching through the application in projects is deemed to grow in unpopularity as the project progressed and only the construction management students believed that a combination of integration, fragmentation and application through projects was a better option at the post stage than they did at the pre test stage.

The negative responses for learning through application in projects can be explained by some of one students response in the individual submission:

'At the first stages of the project my knowledge of sustainability was very low. Nothing has ever really been taught to us, well not in depth about sustainability in my opinion. We briefly passed over it in some modules but this was not enough for me to carry forward with this project'

In the post test questionnaire the students were asked to comment as to how they felt that the School could have improved its teaching and learning so that they would have had a better knowledge of sustainability before they undertook the project.

A summary of the responses is given in table 7.22

1. I think that before we had undertaken the joint project a seminar on environmental issues would have been a good idea to give everyone involved a greater understanding of environmental issues and sustainable construction.
2. A separate module on environmental issues to include the research that we have undertaken for this task.
3. I feel that my discipline of real estate management should be taught more about sustainable construction.
4. The school could run a sustainability module.
5. Personally I think it should either be taught as a module on its own to make everyone aware of environmental issues and sustainable construction as a whole!
6. more joint projects to integrate the professions
7. Making Sustainability a key factor for all projects undertaken in the first and second years of study.
8. with a module dedicated to environmental and sustainable issues at some level in the course
9. Sustainability should be a theme throughout all of the built environment programmes. It should be taught as a separate module at level 1 to reinforce the notion. It should be applied throughout all modules on the courses
10. The school could have integrated a section about the environment into a module or ran a module solely on sustainability and the environment.
11. I believe that the groups could have been smaller, reasonable amount of work for 8-10 people groups of 20 too high to gain a high productivity
12. Module on sustainability
13. Have one lecture for each module about sustainability and the environment referring to the individual modules and how they are affected and where environmental issues come in.
14. With more group projects about sustainability issues and more lectures and tutorials on that area.
15. Integrate it into another subject
16. The school could have helped by incorporating this ideal into the subjects/modules that we have undertaken up to date, as well as teaching us a more construction based view of sustainability.
17. Integrated throughout the course.
18. By teaching the module from day one.
19. Integrated sustainable construction design into Construction Tech and Adv Con Tech.
20. I think that a module of sustainability and sustainable construction should be taught in the first and second years.
21. We could have done a core module on sustainability.
22. The inclusion of sustainability in construction within modules would have given me an improved knowledge of environmental issues before starting the project.
23. It could have been integrated into a coursework or case study to design a building with sustainable features.
24. Integrated it more into construction technology modules.
25. Taught within another subject, needed to know the more basic information on sustainability
26. Maybe a module solely on sustainability would have helped.
27. Should attempt to incorporate sustainable issues into all possible modules as either a specific or recurring background topic
28. Maybe incorporate the importance of sustainability by integrating this during modules
29. By having a lecture on the topic.

30. By incorporating more live projects in each module rather than focusing more on the theory.
31. Via providing sustainability to be taught as a separate subject (fragmented) within the Real Estate Management course.
32. During con tech in year 2 more emphasis should have been put on 'green' construction, and questions in exam should have been worded so to encourage the integration of sustainability into the answer.
33. Site visit of a green building or an eco friendly building.
34. Maybe given 1/2 lectures on the issue within a ConTech module.
35. Integrating the concept of sustainability more in lectures.
36. I think that sustainability should have been taught in other modules or as its own subject beforehand.
37. Emphasis within modules towards sustainability
38. I think that the issue of sustainability could be integrated more within the various modules or even as a separate module in level one and two. It seems that only the design courses are the only ones in the built environment that seem to take sustainability more seriously. There could be a series of lectures on sustainability during the year, of which each student must attend a certain number in order to graduate.
39. More information of sustainability taught within the module criteria.
40. I believe a task such as this should be undertaken in during the 1st or second year. Not just as a 'Sustainable' project but as a project to see how the different disciplines work and integrate.
41. If the university is serious and committed to environmental issues place more emphasis within course modules rather than though a joint project
42. More emphasis on sustainability in previous integrated projects and a module on sustainability.
43. The application of a module dedicated to sustainable design and construction principles
44. To have a module on the subject...
45. have a module that was about sustainable development within the construction industry
46. applied more in other subjects
47. Maybe by having a few lectures on what was going to be involved with the joint project a couple of weeks before this week. Possibly a few research questions as well.
48. Have a separate module on sustainability
49. By including it in subjects taught before the project started
50. Incorporate it more into modules and encouraged to consider it particularly in the design and construction technology modules.
51. Incorporated into modules.
52. To study sustainable technologies in modules in more depth. During lectures there isn't much depth to the knowledge taught about the environment or sustainability, only a vague outline is focused on in lectures.
53. By having a few lectures/tutorials/written material
54. Could have introduced a compulsory module on sustainability issues.
55. It could have been included in earlier modules
56. Have a dedicated 12 credit module in year 2 or year 1 on the subject.
57. Integrate more green aspects in to all areas of teaching where seen fit and perhaps warn that the project might have green requirements so that people with little knowledge can gather some before starting the project.
58. They could have either integrated the issue through modules, or even better, introduced a module solely on sustainability.

Table 7.22 Summary of student responses as to how the School could have better prepared the students for the project.

These responses indicate that there is strong support for integration and fragmentation of sustainability in the students programmes of study. Students generally advocate either integration or fragmentation but there is significant support for both and therefore a combination is probably one which would suit all. This finding is supported by the statistically significant change in the responses for a combination of all approaches between the mid and post test stages with a significance level of .001 being calculated using the Wilcoxon signed ranks test.

Students were asked which sources of information they thought would be, and then subsequently were, the most useful in assisting them when undertaking the project. The mean of the rankings at the three stages are show in chart 7.14

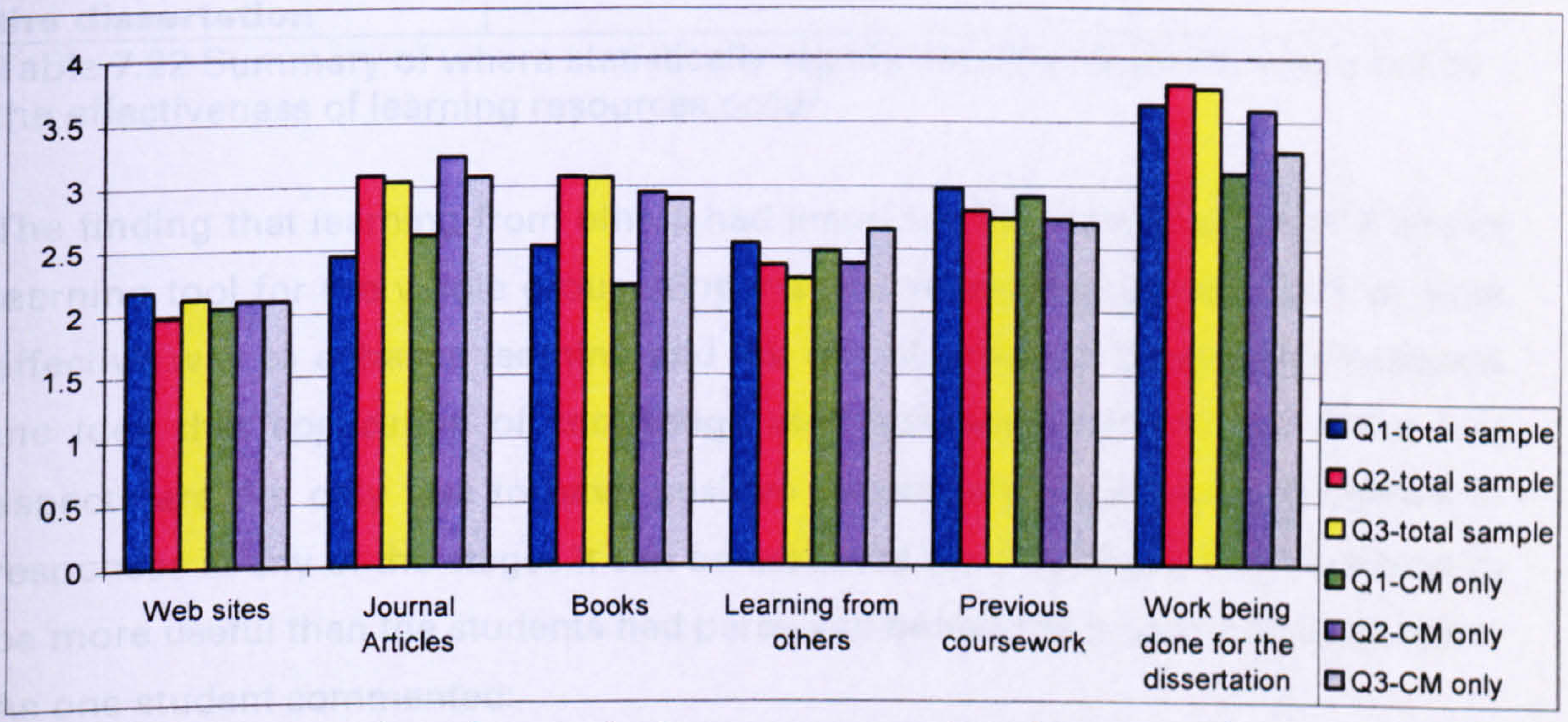

Chart 7.14 Mean values for student responses as to what were the most useful learning resources when undertaking the project

As can be seen, the most commonly perceived learning resource at all three stages was web sites, but the level of support reduced for the construction management students over the duration of the project. Web sites were followed by learning from others and for the whole group, support of this resource increased between the pre and mid and mid and post tests. Journal articles and books were both deemed to be less useful at the mid and post test stages. Previously undertaken coursework was seen as more useful by both groups which supports the previous finding that application of knowledge was deemed to be the main driver for knowledge development and attitude changes, as opposed to newly developed knowledge.

Where statistically different responses were found is summarised in table 7.23. A significance level with a positive sign indicates a positive change, a significance level with a negative sign represents a negative change, and no sign and no number represents no statistically significant difference in responses.

	Pre-Mid test	Mid-Post test
Web sites		
Journal articles	- 0.000	
Books	-0.000	-0.000
Learning from others	+ 0.045	+0.004
Previously undertaken coursework		+0.000
Work being done for the dissertation		

Table 7.22 Summary of where statistically significant differences in responses to the effectiveness of learning resources occur

The finding that learning from others had increased its popularity as an effective learning tool for the whole group supports the notion that group learning is an effective way to enhance learning and the use of previous coursework supports the idea that application of knowledge also enhances learning. As these two aspects are the only two to have positive statistically significant differences in responses at any of the stages it can be assumed that they have been deemed to be more useful than the students had perceived before the undertook the project. As one student commented:

'From research and information shared from other members within the group, I felt that my awareness and knowledge grew to a more confident and acceptable level.'

There were statistically significant differences in responses by different variable groups as follows:

- By mode of study for learning from others at the mid test stage. Full time students found this significantly more useful than part time or sandwich students
- By prior interest in environmental issues for books at the mid test stage. Students not doing a dissertation with an environmental focus believed books to be more important than those who were. By the end of the first semester and half way through a dissertation, the students doing an

environmental dissertation would have already undertaken a lot of reading in this field and therefore not find books as useful

- By prior interest in environmental issues for previously undertaken coursework at the pre test stage. The students with a prior environmental interest believed that previous coursework was more useful than those without a previous environmental interest
- By prior interest in environmental issues for work being done for the dissertation at the mid test stage. As expected the students doing an environmentally themed project found this to be useful in the project. At the pre test stage there was no difference in responses because the students did not know if was about sustainability.

There were no statistically significant differences in responses by mode of study, age, programme or prior environmental interest at the post test stage.

7.2.2.5 Post test supplementary questions

At the post test stage a number of supplementary questions were asked to clarify and further substantiate earlier findings.

The students were asked in what aspects of sustainability their knowledge had increased most. The valid percentages for the responses for the whole group and construction management only illustrated in chart 7.15

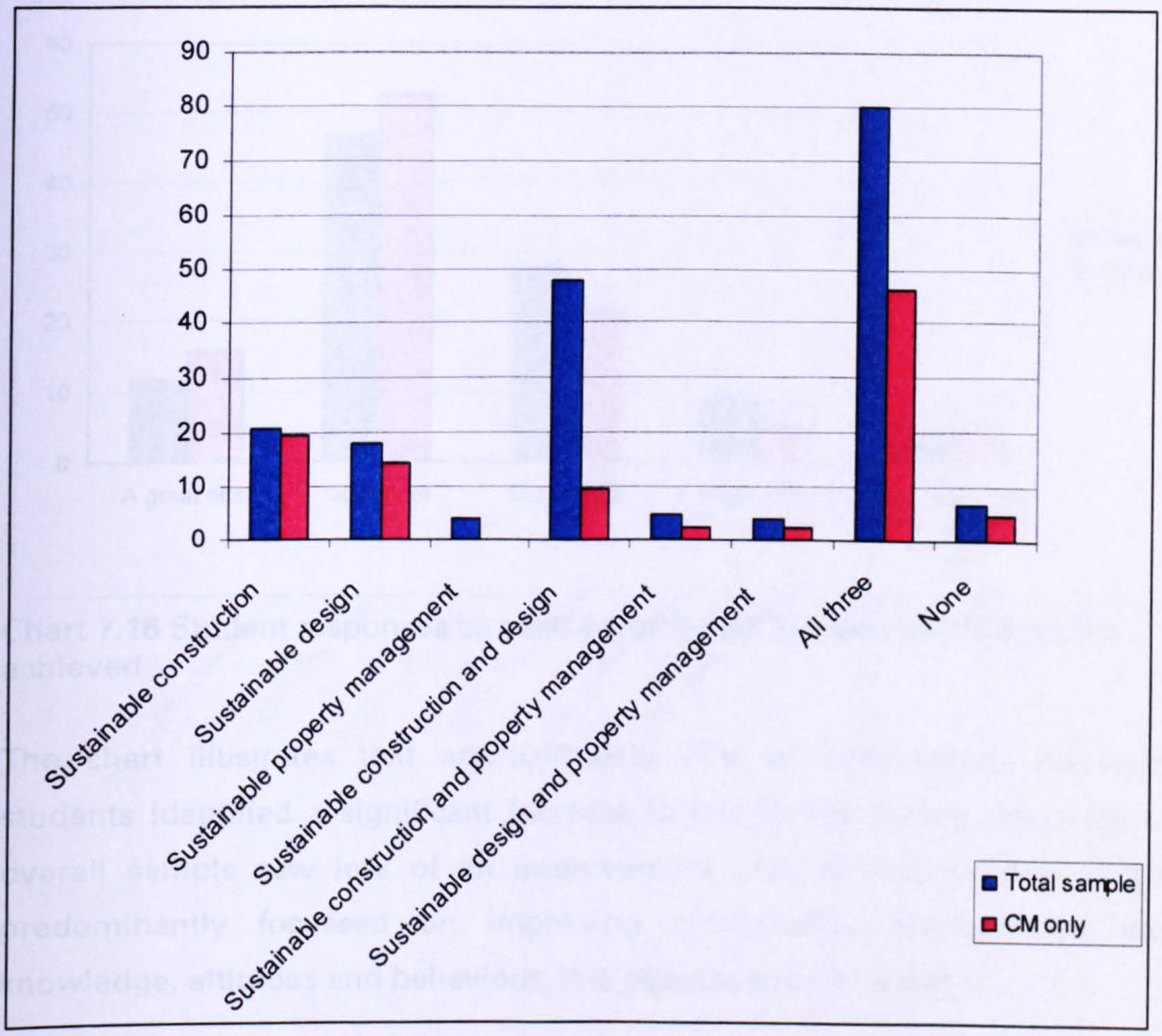

Chart 7.15 Student responses as valid percentages of learning developed via the project

As can be seen, approximately 80% of construction management students saw improvements in knowledge in sustainable construction and/or design. As the aim of the simulation was to increase knowledge specifically in these two areas for this group of students, this is a positive result. For the total sample the most common response(80%) was for all three possible responses, which is to be expected because the other programmes would not have undertaken as mush prior study in this area as the construction management students.

There were no statistically significant responses by age, mode of study, programme or prior environmental interest.

Students were then asked to comment as to how much improvement had occurred, and the results of this are shown as valid percentages in chart 7.16.

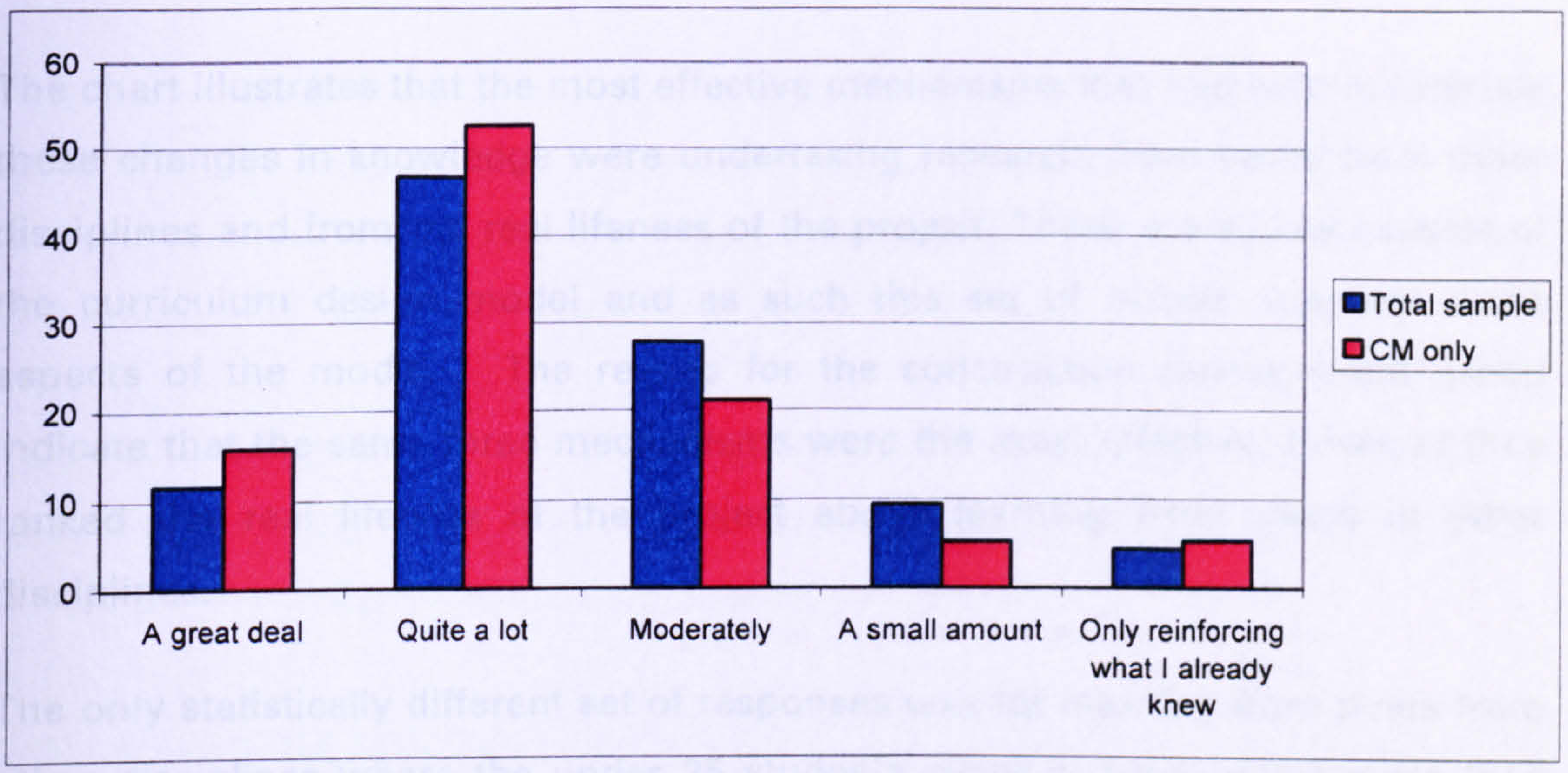

Chart 7.16 Student responses as valid percentages for the level of learning achieved

The chart illustrates that approximately 70% of construction management students identified a significant increase in knowledge during the project. The overall sample saw less of an improvement, but as this research project is predominantly focussed on improving construction management student knowledge, attitudes and behaviour, this again is a positive result.

There were no statistically significant responses by mode of study, programme, age or prior environmental interest.

Students were finally asked what had been the most effective in promoting these changes in knowledge. The mean of the responses for both the whole group and the construction management group are illustrated in chart 7.17

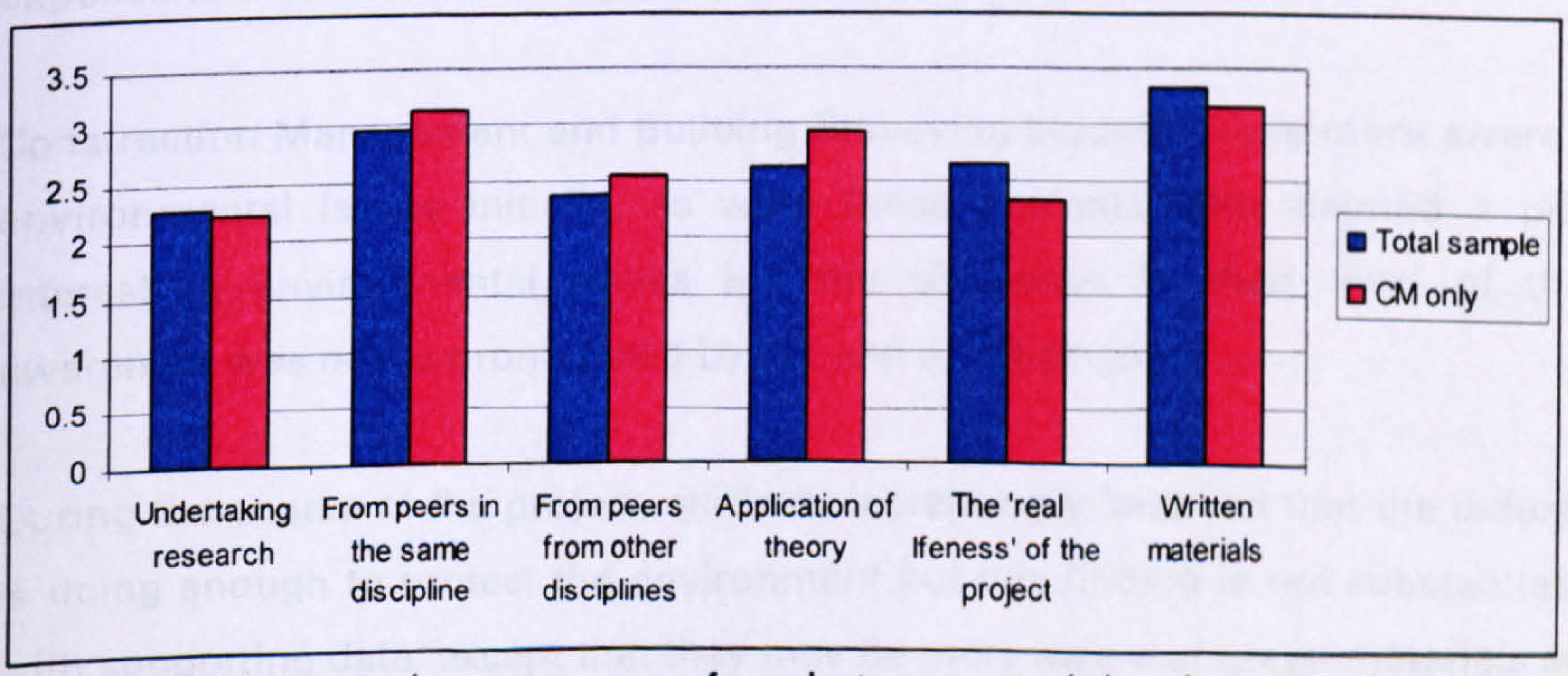

Chart 7.17 Mean student responses for what promoted the change in knowledge

The chart illustrates that the most effective mechanisms that had helped facilitate these changes in knowledge were undertaking research, from peers from other disciplines and from the real lifeness of the project. These are all key aspects of the curriculum design model and as such this set of results supports these aspects of the model. The results for the construction management group indicate that the same three mechanisms were the most effective, however they ranked the real lifeness of the project above learning from peers in other disciplines.

The only statistically different set of responses was for learning from peers from other disciplines where the under 25 students claim to have learnt more than those aged over 25. The significance level was 0.023 and the association weak, but still statistically significantly different. This is probably an expected results as the more mature students tend to be the part time students with more experience. It would be expected that full time, less mature students would learn from them rather than the other way around.

7.3 Summary of findings

The analysis and subsequent interrogation of the data enabled the following main findings to be identified.

Student perceptions of their awareness of environmental issues did increase over the duration of the project, but the awareness was raised more in full time than part time students. This is possibly because of part time students being more exposed to these issues during industrial experience.

Construction Management and Building Surveying students were more aware of environmental issues initially, as were those students who claimed a prior interest in environmental issues but the difference in their level of their awareness was not as pronounced by the end of the project.

During the course of the project, students increasingly believed that the industry is doing enough to protect the environment but this finding is not substantiated with supporting data, except that they may be more aware of green materials and environmentally friendly systems.

This finding was contradicted by the student opinions of how important they think industry views environmental friendliness of construction work and buildings which was ranked as the least important factor that industry considers and which went lower as the project progressed.

Part time students also contradicted this opinion and the findings of the literature review in 2.3 in stating in the individual competency audits that industry has not embraced sustainability as fully as required to see any real changes.

However, generally it can be concluded that awareness of the environmental impact of construction work and buildings plus the priority that the industry places on environmental issues had increased significantly.

Students' knowledge increases were generally inconsistent and in the technical knowledge aspects the results were generally worse at the end of the project than at the beginning, although for the construction management group the results were better than for the whole sample.

For knowledge of procurement routes there was a similar pattern but this was less marked and a positive finding was that knowledge of whole life value procurement methods had improved during the project. This was the only aspect where the construction management group had a better knowledge than the whole group at the end of the project, which is reassuring.

Also, encouragingly the number of 'don't know' responses had reduced quite significantly by the end of the project demonstrating a growth in knowledge by some students.

For the factors that could affect future lease and/or resale of commercial buildings, no measure of correctness was employed but there was a very significant reduction in 'don't know' responses. Knowledge of BREEAM had certainly increased significantly by the end of the project.

The results indicate that there was a greater increase in knowledge for these aspects than there were for procurement methods and most certainly for technical aspects.

In summary, knowledge had not changed very greatly over the course of the project and in some instances had decreased. But, there was support for the notion that application of prior knowledge had enhanced and consolidated that knowledge during the project.

Perceptions of the use of PDP to enhance learning positively increased during the project, and changes were significant especially for the under 25 and/or full time students.

Attitude changes were significant especially between the mid and post test stages. The attitudes of the under 25 and/or full time students changed the most.

Changes appear to be due to knowledge changes, but not new knowledge acquired. The knowledge changes have occurred because of application of prior knowledge.

At the end of the project the construction management students ranked environmental friendliness in the context of construction and buildings more highly than the total sample and more important than costs, aesthetically pleasing and short duration. Only quality of work and health and safety were ranked higher which is a very good gauge of positive attitude changes for the construction management group.

The students' awareness of the time it will take for them to have any real impact on the practices of the construction industry changed over the project duration. The shift was predominantly from five years to ten years before they will be able to influence practices significantly and part time and sandwich students were generally the most realistic in these predictions.

Results showed that potential behaviour with regard to informing clients was deemed to be more important after the project was completed and therefore it can be assumed that the previously established changed attitudes could inform future behaviour. Some students identified that they may not be able to change industry practices significantly but that they could change their own behaviour and this was supported by the increase in positive responses regarding paying more for a house if it contained green products or systems at the post test stage. 35% of the respondents stated that they would definitely or probably pay more for a greener house at the post test stage whilst at the testing in phase 1 where there had been no intervention, only 12% responded that they would.

For the total sample interdisciplinary groups were deemed to be more useful as learning tools at the mid stage of the project but then reverted to being less useful at the post test stage. However for the construction management students only there was deemed to be an increase in the usefulness of interdisciplinary groups to enhance learning for both large and small group sizes at the post test stage.

Students perceived the benefits of group work to be greater at the end of the project than at the pre test stage which is a positive change. Learning from others was deemed to be the second most useful effective aid to learning, which supports the claim that attitudes to group working had become more positive as the project progressed.

There were inconclusive results for the perceived enhancement to learning by using real life cases studies. Whilst the quantitative data analysis found perceptions of its usefulness to reduce over the duration of the project, the qualitative data showed more positive responses.

The results found that the most common responses as to how the students would have been better prepared for the project were predominantly, more fragmentation using specific environmental modules, more integration in the main core subject or a combination of both. These responses were due to the fact that most students identified that they needed more knowledge of sustainability beforehand. As the findings have previously shown that the greatest increases in knowledge arose from the application of previous knowledge and that this increase in knowledge had a positive influence on attitudes, the combination of both approaches would appear to be a sensible approach. The qualitative data also collected supports this finding.

80% of construction management students identified an increase in knowledge in sustainable construction and/or design. This is a very positive results and is strengthened by the fact that 70% saw the improvement in knowledge a 'quite a lot' or 'a great deal'.

The following statement taken from an individual student submission summarises and supports a number of the major findings:

'During the course of the week my attitude towards sustainability has changed considerably. On a personal level I knew that it was a big issue that needed to be addressed with some urgency, but I also believed that I would not be able to make a big difference to the industry as I thought that the cost of sustainability was too much. Now though my opinion has changed. In terms of personal lifestyle I am making a more conscious effort to reduce my effect on the environment, for the first time this semester I did some recycling this week, and when it comes to finding a new flat for next year I will be more conscious of environmental issues. In terms of my career I felt that sustainability would be entirely driven by building regulations, but now I feel with the application of skills learnt during the week that I can push clients a step further than just meeting regulations, and not just for environmental reasons but also because I can show them the long term cost benefits of implementing these greener solutions. Through research for this project, group discussions and listening to the presentations I have got a much better understanding of how these new sustainable technologies and simple practices can be incorporated into buildings and their construction to limit the impact of construction.'

The specific research hypothesis developed to be tested in this phase of the research work was:

'Student knowledge will increase rapidly, but attitudes will change slowly'

However this hypothesis was rejected because knowledge actually change insignificantly and what change did occur were due to application of prior knowledge. Attitude changes were significant though and this is a better conclusion than expected because it is attitudes and not knowledge than change behaviour.

8.0 Conclusions and future work

8.1 Conclusions

The major findings of the research project are detailed in this chapter. The research aim is revisited in 8.1.1 to evaluate the success of the project, and the acceptance of the research hypothesis is discussed. 8.1.2. identifies the differences and similarities between the findings of the literature review and subsequently collected data at all phases. In 8.1.3 the validity, applicability and level of success of the principles of the model, after testing in phase 3, are assessed.

8.1.1 Review of the aims and hypothesis

The overall aim of this research was to produce a set of well-developed concepts that could be used to explain or predict phenomena related to curriculum modelling. These concepts were derived from data that has been systematically gathered and subsequently analysed and a model developed that may be used to supplement existing professional body guidance for curriculum design that aims to promote literacy in sustainability.

This aim was achieved and the concepts were used to develop the 'Paradigm for Sustainable Construction Curriculum Design' model

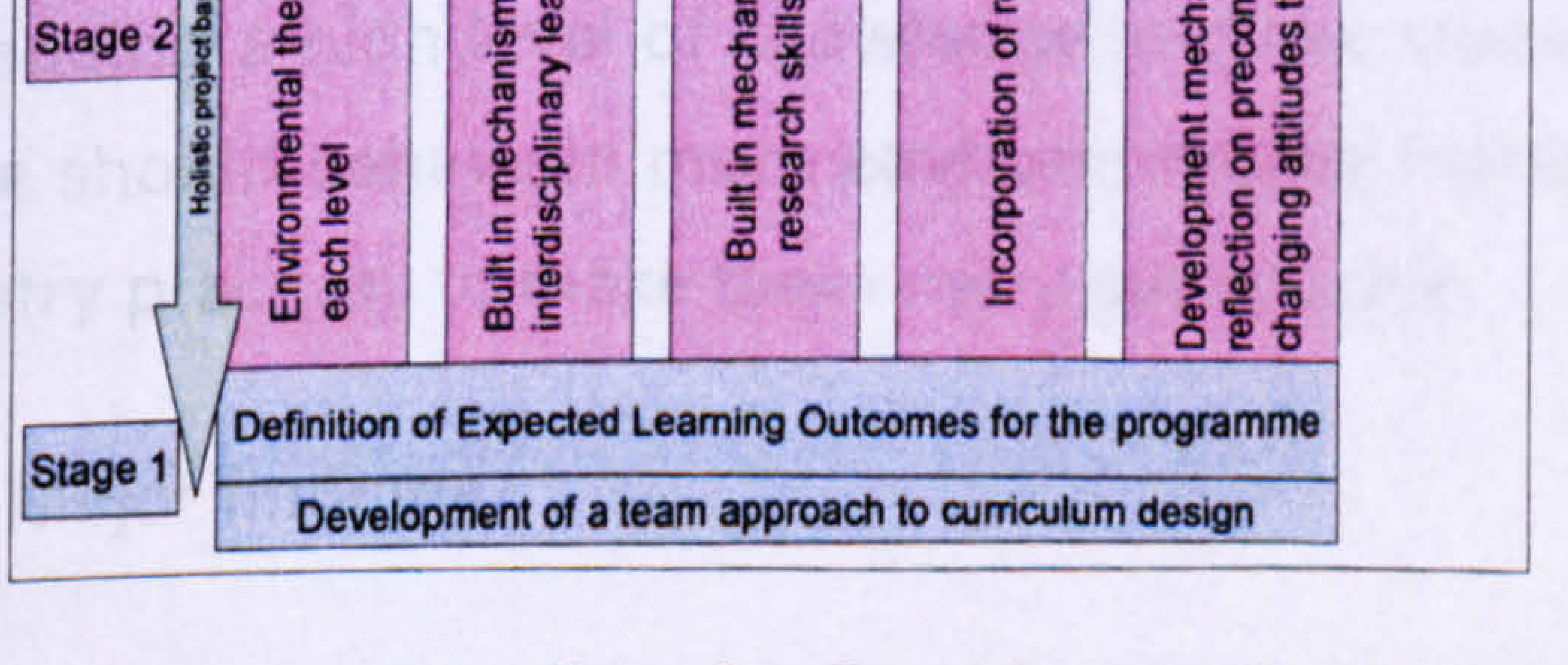

Figure 8.1 The Paradigm for Sustainable Construction Curriculum Design

Testing of the model in phase 3 lead to the finding that some of the recommendations for interventions were more successful than others

In addition the following hypothesis was to be tested:

'Well researched and applied curriculum interventions in sustainability may improve student knowledge, and positively change attitudes and behaviour in construction professionals of the future'

The findings of phase 3 proved the hypothesis to be accepted and correct but not in its purest sense. The major anomaly found with the hypothesis is that a short term intervention proved unsuccessful in increasing knowledge although attitudes changed positively and early indications are that this may change behaviour. Knowledge only appeared to change with the application and contextualisation of previously acquired knowledge and this supports the notion that including environmental issues early on in the curriculum and having a theme that runs through the programme is the way to develop the knowledge required for application. Therefore even though the small scale intervention of the proposed whole curriculum model did not identify any increases in knowledge, the precept is that the implementation of the model over the whole curriculum should prove successful.

8.1.2 Contribution to original knowledge

The original knowledge attained by the undertaking of this research project is the finding that the implementation of the curriculum interventions proposed by the Paradigm for Sustainable Construction Curriculum Design model can change attitudes significantly. Therefore the model is the contribution to original knowledge.

The changes are more evident in under 25 and/or full time students. By embedding a high level of knowledge in these students, the professionals of the future should behave in more environmentally friendly ways and in time change industry practices to make them more sustainable.

8.1.3 Major findings

The first stage of the literature review focused on determining definitions for the terms sustainable construction and design. Leal Filho (1999) advocated that rather than debating the wider context of sustainability, industries should concentrate on defining sustainability in specific terms that have relevance and applicability to them. It is the concentration on trying to determine the more holistic aspects of sustainability that has lead to confusion and therefore inertia in the changing of practices. Dammann and Elle (2006) found in their research that this ambiguity was still an issue, seven years later. This finding was supported by the data collected from industry representatives via a questionnaire. The industry representatives appeared to have a very limited knowledge of the more technical terms of sustainable construction and design, but were able to define sustainable development, although not in any great detail.

It is therefore very important that students understand what these terms mean. The students identified that they need to know about sustainable design and construction in detail, but also about sustainability and sustainable development so that they can understand the more technical terms in the context of the whole sustainability debate. The acquisition of this knowledge earlier in the curriculum was advocated because the phase 3 test identified that the project was not the place to acquire new knowledge, rather a project should be used to consolidate prior knowledge by application of theory.

The literature review identified that predominantly the structure and nature of the UK construction industry are not ideal for the promotion of sustainability, but there are some practices that are more conducive to the adoption of sustainability than others. For example whole life value approaches to procurement are much better than traditional methods. The industry needs to change and the adoption of a sustainability strategy-for change would be the most effective. This requires an understanding and tolerance of the complexities involved, and the decision makers of the future will need to adopt new values that reflect the aims, objectives and aspirations of sustainable development. The current construction industry that is used to short time horizons with defined, discrete client groups may find the risk of including and responding to a range of stakeholders and potential clients too high. However the future professional, if very knowledgeable about all aspects of sustainable design and construction may be more willing to take these risks.

For this approach to be fully adopted organisations would need to understand the relationship of the business activity to the impact of the final product. They must care for future generations which may involve including younger people in the decision making process and utilising small work teams to define responsibilities at the lowest level possible. It requires an ability to attend to detail at the site of the problem, and respond quickly and innovatively. This is where the students of today can be utilised to a greater extent earlier in their careers.

However not all the blame for the lack of impetus in sustainable design and construction falls on the industry, clients need educating. Shiers(2006) blames the lack of greening in the industry at the door of clients because he claims that they do not require the industry to demonstrate environmental credentials. Orr(1992) believes that the only way to develop educated clients is by educating everyone about environmental issues at primary and secondary education levels. However he also states that it is the university sector that will make the greatest impact in sustainability as it has the opportunity to shape the leaders of tomorrow.

The impact of the project, which was a small scale simulation of the sustainable construction curriculum model, changed student perceptions as to the importance of advising clients between the pre and post test stages. After completing the project the students believed it to be much more important to inform clients as to the environmental impact of their construction work. Students believed that building in an environmentally friendly way was much more important than they think industry believes it to be. Therefore the professionals of the future should be able to inform clients and stress the importance of building green rather than building cheap.

Previous writes have identified that policy and regulation can only go a certain way in changing behaviour in a democracy. Therefore education that can change attitudes and then behaviour is crucial for change. The students of today should be the educated professional of the future and should be able to change practices through advising clients and adopting sustainable strategies for change in organisations.

The phase 3 testing demonstrated that awareness and knowledge can improve if the model for curriculum design is adopted but the increase in knowledge was not as significant as expected. Knowledge appeared to increase by the application and contextualisation of previously attained knowledge rather than the development of new knowledge. It had been envisaged that student knowledge would be greater than it was and this lack of knowledge supports inclusion of environmental subjects earlier on in the curriculum.

However, and a possibly more important finding, was that attitudes had changed significantly and positively. To test whether behaviour would subsequently change was difficult to determine but an early indication that it could, was the fact that many more students stated they would pay more for a house if it contained environmentally friendly products and systems after the project was completed than at the beginning. The hypothesis developed at the start of phase 3 was that student knowledge would increase rapidly but attitudes would change slowly, however this was rejected by the end of the project and the analysis of the data. Knowledge had changed slightly but attitudes had changed significantly through the application of prior knowledge.

Wemmenhove and de Groot (2001) found in their research that students need be trained as to how to communicate with the non-academic society to be able to provide advice. Interactive communication skills are developed in either one to one or group based scenarios, but the group based scenario is more difficult for some students who lack confidence. Therefore the inclusion of group work in the curriculum should enhance those skills. Group work has also been mooted by the students as a useful learning tool, and their perception of its usefulness increased as the project developed. Interdisciplinary groups were seen to increase knowledge more than single disciplinary groups by the end of the project. This supports the idea that interdisciplinary approaches should be practical and applied as in projects, rather than students just being taught together as advocated by Fettig (2002). The students' previous experiences of interdisciplinary approaches were simply sitting in a lecture room with students from other programmes and they deemed the learning experience of undertaking a project in groups with students from other programmes to be beneficial to their own learning. However it has to be stated here that this depends on the type discipline and may only be relevant for built environment students.

The professional body is important in informing curriculum design, but educational frameworks need to cover all aspects of construction management rather than just sustainable construction and design. The professional body therefore needs to take a responsible approach when developing a framework, that embraces current construction practices and innovations that can lead to improved performance. Therefore universities must take some responsibility for internal evaluation via validation mechanisms as advocated by the Toyne Report (1993) for ensuring sustainability is a key factor is every curriculum. There is no evidence that this is being done and therefore external accreditation by the professional body is the only mechanism to check that this is the case for construction management programmes. Therefore the adoption of a framework that details very specific expected learning outcomes that have been devised by industrial and academic advisors is seen to be good practice.

However as seen in phase 1, although the educational framework is deemed to be restrictive it is actually quite flexible. The supplementary use of the curriculum design model would therefore be possible and could encourage more lateral thinking for an increase in sustainability in the curriculum.

Unfortunately there were no significant differences between the findings at Australian universities to those in the UK. It had been envisaged that there would be some elements of good practice that are not utilised in the UK, which could have been incorporated into the model, but this was not the case
The only differences were that in Australia the programme leaders believed that students were relatively knowledgeable about environmental issues before they started at university, but in the UK the perception was that students were less so. This reflects on primary and secondary education rather than tertiary and thus is not relevant to this project. In the UK, the university itself is perceived to have more influence on the curriculum than in Australia and this would be a good thing if the recommendations of the Toyne Report had been universally adopted, but unfortunately there is no evidence that they have.

The major barrier for not incorporating more sustainability in the curriculum was identified as lack of willingness by academic staff to develop the required knowledge themselves because of a lack of time or other dominant research interest, and/or lack of willingness to teach these aspects due to lack of time to prepare materials. These statements were supported by the findings of the literature review and the data collected in phases 1 and 2. However as the project proved successful in achieving its aims, it can be demonstrated that only a small number of academic staff need to be fully knowledgeable in these areas for improvements in knowledge and attitudes to be observed. However the increase in knowledge came from the application of prior knowledge and students advocated that this knowledge would be best generated via a combination of integration and fragmentation early on in the curriculum. Therefore more academics would need to familiarise themselves with the environmental aspects related to their subjects, and this could be a problem if there is a lack of engagement in this.

8.1.4 Validity of the principles of the model

The level of success of each of the principles used, as the basis for the model used to design the simulation are detailed in table 8.1.

<u>**Principle 1**</u> **The curriculum should be designed using Expected Learning Outcomes as the starting point.**
Expected Learning Outcomes for the programme should be determined followed by learning outcomes for each level. Learning outcomes for each module should then be devised.
<u>Application and Success</u> The Learning Outcomes approach was used to develop the project, with the following being the main driver: *'After completion of the programme, students will have a knowledge of sustainable construction and design and skills to enable solutions for environmental problems to be developed'* However, as has already been stated there is no evidence that knowledge improved after the project, but previous knowledge was consolidated and there was evidence of improvement in understanding after practical applications of that knowledge. This aspect of the simulation therefore proved unsuccessful but did lead to the finding that opportunities for the development of knowledge need to be embedded throughout the curriculum. Therefore over the longer term knowledge will increase.

<u>**Principle 2**</u> The curriculum should be holistic
The curriculum should not be designed as a series of discreet modules. They should be complementary.
<u>Application and Success</u> Project modules allow the bringing together and application of knowledge and skills. This aspect of the simulation proved highly successful as application of knowledge proved to be an effective learning tool. Project work is generally undertaken in groups and the students believed group work to be far more effective as a learning mechanism at the end of the project than at the beginning.

Principle 3 **Environmental aspects should be delivered via the curriculum in both integrated and fragmented ways.**
There should be reference to sustainability in the majority of modules in the correct context, and in addition there should be bespoke modules that address this issue.
Application and Success This aspect of the simulation was successful there was an overwhelming response that there should be more inclusion of environmental subjects in the curriculum with the majority stating this should be integrated, fragmented or a combination of both. Therefore a dual approach would suit the majority. Interestingly there was little support for the development of new knowledge using project modules.

Principle 4 **The curriculum should be designed around themes**
A series of themes should be identified and these themes should develop though the curriculum..
Application and Success The themes that were identified are Technology, Science and Environment, Law and Management, Research, Application and Specialism. The Specialism modules are those that have developed from staff expertise All of these themes were addressed during the simulation but the level of success could not be judged by the simulation. The success of this themed approach to curriculum development may only be tested over a longer term.

Principle 5 **The curriculum should be designed to enable as much interdisciplinary learning as possible.**
Application and Success There was much support for the benefit of interdisciplinary working to enhance learning. Therefore this aspect of the simulation proved successful. Following this success there needs to be further work done to the developed curriculum to try to build in more opportunities for this earlier in the curriculum.

Principle 6 **There should be opportunities to allow for the use of real life case studies in the curriculum to enhance the learning experience.**
Students may only see the relevance of teaching and assessment if it is related to real situations.
Application and Success This aspect of the simulation proved less successful than had been envisaged. There were inconclusive results for the perceived enhancement to learning by using real life cases studies. Whilst the quantitative data analysis found perceptions of its usefulness to reduce over the duration of the project, the qualitative data showed more positive responses.

Principle 7 **There needs to be a mechanism embedded in the curriculum that will enable the students to reflect on preconceived beliefs and undertake a critical analysis of their attitudes to the environment.**
This can be achieved via PDP
Application and Success This aspect proved to be successful in the simulation with students perceiving that the use of PDP to enhance learning to be more beneficial at the end of the project than at the beginning. The most marked change in the perceptions of its benefits were for the full time and/or under 25 students..

Principle 8 **There needs to be a mechanism embedded in the curriculum that will enable the students to develop and practice research skills**
Students sometimes struggle with the concepts of research methodology and referencing because of a lack of exposure to these earlier on in their studies.
Application and Success This aspect of the simulation proved moderately successful with students ranking learning by research as their third most preferred option after web based resources and group learning. The perception of the benefits of research to improve learning improved as the project progressed.

Principle 9 **The staff resource needs to be encouraged and developed to deliver a curriculum based on principles 1-8**
The writing of a curriculum may be undertaken by one person only, but the delivery will be undertaken by a group. 'Buy in' of staff is therefore required.
Application and Success The success of this aspect is difficult to assess. All the academic staff involved in the project were interested in sustainability and therefore 'buy in' was inevitable. However to test whether this can be achieved the curriculum would need to be implemented and this will not occur until September 2008..

Table 8.1 Summary of the success of the principles used to develop the curriculum design model

These findings illustrate that the principles that proved to be the most successful in the simulation were the development of a curriculum using an expected learning outcomes approach, the inclusion of a combination of integration and fragmentation for sustainable knowledge development at each level, the inclusion of interdisciplinary working and personal development planning opportunities. Additionally there is support for the holistic approach to curriculum design and this can be overcome in a modular curriculum structure using projects. There was support, but to a lesser extent, for the benefit of undertaking research as a learning tool, but even with limited support this finding validates the inclusion of a research methods module earlier in the programme. There was little support from the students for the benefit of using real life projects as an aid to learning, but as has already been stated the results were inconclusive. If the qualitative data had been used solely to determine whether students believed this to be a good idea, then the results would have been very supportive of this aspect.

It was not possible to test whether a themed approach to curriculum design would enhance knowledge and change attitudes during the project as this would have to be tested over a longer time. However the inclusion of an environmental theme must be successful as it supports the notion of fragmentation which has advocated as being of benefit.

In conclusion, the simulation of model via the project proved to be successful in changing attitudes especially. Therefore its implementation over the whole curriculum should be even more successful but this can only be tested over time. The real test is whether there are behavioural changes in graduates of the programme, but that will require waiting for at least eight to ten years and will be the focus of further research in the future. However all the indications are that the curriculum changes proposed may:

'acquaint students with the major issues and enable them to make the leap from 'I know' to 'I care' to 'I'll do something'. (adapted from Orr (1992)p.147)

8.2 The journey

Undertaking this research project has been likened to going on a journey but not knowing where you are going and not knowing how you are going to get there. There have been many successful activities and some less so, but learning from the unsuccessful activities is a very useful exercise. The unsuccessful activities included:

- Lack of variables in the industry data collection of phase 1, which meant that statistical analysis of the data, was not possible
- The two abortive attempts of the analysis of the qualitative data in phase 2
- The lack of success of the industry feedback questionnaire in assessing the validity of the model.

However everything else undertaken was positive and successful and ultimately the aims of the project could be achieved.

The journey end is reached as far as the PhD work is concerned, but there is further to go. Future planned work and the continuation of the journey are outlined in 8.3

8.3 Planned future work

The findings of phase 6 are that the implementation of a short sharp shock initiative, based on the 'The Paradigm for Sustainable Construction Curriculum Design' model in the curriculum can improve awareness, knowledge and attitudes. However the project used was only a simulation of a much greater initiative and as such, testing of the model will continue for many years. Initial data will be gathered at the end of the academic year of 2007-08. This will assess the knowledge, skills and attitudes of the graduates of construction management via a quantitative methodology. Data will then be gathered at the end of every academic year until the student cohort of 2008, graduates. Comparisons can then be made to gauge how much improvement there has been. In addition it is planned to hold focus group meetings with students throughout the course of each academic year to gather qualitative data. The programme will be revised again in 2012 and all findings will feed into this review.

There were some potential barriers identified regarding implementation of the model and future work is planned to try to overcome these barriers, the major one being academic staff engagement in integration of sustainability in all core modules.

The main reason cited by the programme leaders in phases 1 and 2 for not increasing the amount of environmental content in their programmes was lack of staff knowledge and motivation. Myself and a colleague, Paul Murray, from the University of Plymouth have submitted a National Teaching Fellowship bid which focuses on strategies to 'teach the teachers' and 'train the trainers' in environmental issues relating to construction and property. If successful the funding will allow for the production of staff development packages that can be used by lecturers to incorporate sustainability in their programmes with little effort. There will also be a series of workshops held around the country and academic staff will be invited to these to update their sustainability knowledge and see demonstrations of innovative tools that can be utilised. Twenty universities have already expressed interest in participating in these events. If the bid is not successful, alternative funding will be sought and the project may be expanded internationally.

A problem encountered by the author during development of the case study curriculum was that of increasing the amount of interdisciplinary learning opportunities and the findings of phase 3 support more extensive inclusion of this. Further research will be undertaken to identify methods of achieving this, which will feed into the curriculum when appropriate.

Therefore the work undertaken to date is not complete and will continue for many years. It is hoped that this continuing work and the work done to date will make real changes in the education of construction students who will take this knowledge into the industry and make real changes to stop damage to the environment, or at least slow it down.

Findings of some of this research work have been peer reviewed and published in the following forms:

Conference Papers

Cotgrave, A(2003)'Greening the Built Environment Curriculum.' BEAR International conference for construction education. University of Salford

Cotgrave A, Alkhaddar R(2004) 'Greening the Curriculum of Construction Management Programmes' COBRA conference, Leeds

Refereed Journal Articles

Cotgrave, A., (2005) Tuning the Undergraduate Construction Curriculum : Embedding Health, Safety and Environmental Issues in Order to Improve Employability", CEBE Transactions, Vol 2, , Issue 1, April 2005.

Cotgrave A , Alkhaddar R. (2006)"Greening the Curricula within Construction Programmes", Journal of Education in the Built Environment JEBE, vol 1, issue 1, pp 3-29, , April, ISSN: 1747-4205 (Online), http://www.cebe.heacademy.ac.uk/jebe/index.php

Murray P., **Cotgrave A**.(2007) Sustainability literacy: the future paradigm for construction education?, Structural Survey, Vol.25 No.1 2007

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Appendices

Phase 1

a. Sustainable Construction Questionnaire

The information derived from this survey will be used to assist in the evaluation of the value of incorporating environmental issues into the Built Environment curriculum, and try to establish whether the professional bodies who accredit the programme should be more proactive in encouraging construction related programmes to be developed with an entirely environmental context.
I would be grateful if you would answer the following questions as honestly as possible. Please circle the appropriate answer or tick the correct box where applicable

Course of Study: **Construction Management Architecture Services Engineering**

1.How aware do you feel you are of environmental issues, specifically with regard to the Built Environment?

Very Aware	Aware	Unaware	Very Unaware

2. Are you more aware than you were before you commenced your studies in Higher Education?

Yes	No

3. Have you had focussed exposure to environmental/sustainability issues in any of the following?

	Yes	**No**
Modules		
Lectures		
Assessment		
Group base projects		
Practical work		

4.

	Yes	**No**
Has you attitude to the environment changed since you started your degree programme?		
Do you believe personally (regardless of any other opinion) that the issue of the environment is important?		
When buying your own house, would you pay more if it included more environmentally friendly products or systems?		
Do you believe that technology alone can solve the environmental problems the world faces?		
Do you think that the Construction Industry poses a major threat to the environment?		

5. How would you rate the following materials or systems environmentally?

	Very Damaging	**Damagi ng**	**Averag e**	**Goo d**	**Very Good**
UPVC pipes					
Photovoltaic cells					
Concrete					
Clay drain pipes					
Refurbishment					

6. Do you think the construction industry does enough to protect the environment?

Yes	No

7. How important do you consider it to be that whilst at University you develop an in depth knowledge of the impact of the construction industry on the environment?

Very Important	Important	Not Important	Very Unimportant

8. How important do you think it is for construction professionals to inform the general public about the effects of construction work on the environment?

Very Important	Important	Not Important	Very Unimportant

9. Do you think your future employer will give you all the training you need with regard to environmental practices?

Yes	No

10. How highly important would you rate the following factors in relation to a building project?

	Very High	High	Average	Low	Very Low
Cost					
Time					
Quality					
Health and Safety					
Environmentally friendly					

11. Rate the following procurement methods between 1 and 5(1 being the highest) as to how effective they are for encouraging the use of sustainable construction techniques.

Design and Build	
Construction Management	
Private Finance Initiative (PFI)	
Traditional (open or selective)	
Partnering	

12. What is the relevance of your future career to the issue of the environment?

____

____

____

13. Does your dissertation/final year project have any of the following words or phrases in its title: Environment, Environmental, Sustainable, Sustainability, Green, Energy Efficiency.

Yes	No

THANKYOU FOR COMPLETING THIS QUESTIONNAIRE

b. Sustainable Construction Questionnaire

The information derived from this survey will be used to assist in the evaluation of the value of incorporating environmental issues into the Built Environment curriculum, and try to establish whether the professional bodies who accredit the programme should be more proactive in encouraging construction related programmes to be developed with an entirely environmental context.
I would be grateful if you would answer the following questions as honestly as possible. Please circle the appropriate answer or tick the correct box where applicable

Mode of Study: **Full Time** **Sandwich(thick or thin)** **Part Time**

1.How aware do you feel you are of environmental issues, specifically with regard to the Built Environment?

Very Aware	Aware	Unaware	Very Unaware

4. Approximately, how much of your programme of study has included environmental/sustainability aspects of construction under the headings listed below?

	100%	**75%**	**50%**	**25%**	**0%**
Modules					
Lectures					
Assessment					
Group base projects					
Practical work					

3.

	Yes-Very Much	**Yes-but not much**	**Mayb e**	**No**
Has your **attitude** to the environment changed since you started your degree programme?				
Do you believe **personally** (regardless of any other opinion) that the issue of the environment is important?				
	Defini tely	**Proba bly**	**Mayb e**	**No**
When buying your own house, would you pay more if it included more environmentally friendly products or systems?				
Do **you** believe that technology alone can solve the environmental problems the world faces?				
Do **you** think that the Construction				

Industry poses a major threat to the environment?				

4. How would you rate the following materials or systems environmentally?

	Very Damaging	**Damagi ng**	**Averag e**	**Goo d**	**Very Good**
UPVC pipes					
Photovoltaic cells					
Concrete					
Clay drain pipes					
Refurbishment					

5. Do you think the construction industry does enough to protect the environment?

Yes	No

Why? ____

____

6. How important do you consider it to be that whilst at University you develop an in depth knowledge of the impact of the construction industry on the environment?

Very Important	Important	Not Important	Very Unimportant

7. How important do you think it is for construction professionals to inform the general public about the effects of construction work on the environment?

Very Important	Important	Not Important	Very Unimportant

8. Do you think your future employer will give you all the training you need with regard to improving environmental practices in the construction process?

Yes	No

In the following two tables, rate the factors between 1 and 5 in order of importance(1 being the highest importance). Please use each number once only.

9. How important do <u>**you**</u> rate the following factors in relation to the construction of a building?

Low Cost	
Short Contract Duration	
Good Quality of Work	
Good Health and Safety Record	
Environmentally Friendly	

10. How important do you think the Construction Industry generally believes the following factors are in relation to the construction of a building?

Low Cost	
Short Contract Duration	
Good Quality of Work	
Good Health and Safety Record	
Environmentally Friendly	

11. Rate the following procurement methods between 1 and 5(1 being the highest) as to how effective they are for encouraging the use of sustainable construction techniques.(Please use each number once only)

Design and Build	
Construction Management(contractor acts as a consultant)	
Private Finance Initiative (PFI)	
Traditional (open or selective tendering)	
Partnering	

12. What is the relevance of your future career to the environment?

____

____

____

13. Does your dissertation/final year project have any of the following words or phrases in its title: Environment, Environmental, Sustainable, Sustainability, Green, Energy Efficiency.

Yes	No

THANKYOU FOR COMPLETING THIS QUESTIONNAIRE

c.

Research title: Greening the Curricula of the Built Environment
Structured interview questions for Programme Leaders of Construction Management undergraduate programmes accredited by the CIOB under function D (Construction Management) at UK Universities

Interviews to be conducted by telephone-Spring 2002

1.0 General Questions
- 1.1 Are you involved in the design of the curriculum for the Construction Management programme?
- 1.2 When was the programme last validated by the CIOB?
- 1.3 Have you made any significant changes since that validation?

2.0 Course Design
- 2.1 Do any of the aims and/or objectives of the programme make specific reference to the environment/sustainability?
- 2.2 Do any modules have learning outcomes that make specific reference to the environment/sustainability?
- 2.3 If yes, what are the module names?
- 2.4 Are there any assessments within the programme where the focus is predominantly environmental issues?
- 2.5 How are sustainability/environmental issues taught on your programme, integrated or fragmented?
- 2.6 At what level/stage of study is sustainability introduced?
- 2.7 Does the concentration on these issues increase through the levels, decrease or remain constant?
- 2.8 Does your school/department promote interdisciplinary education? If yes, with which other programmes?
- 2.9 What assessment approach do you think best develops a deep understanding of environmental issues, that can change attitudes?

3.0 Educational Framework
- 3.1 Do you think the CIOB educational framework puts enough emphasis on environmental issues?
- 3.2 The proposed new framework is supposed to be more flexible. If that is the case would you consider increasing the amount of environmental studies in your programme?
- 3.3 If yes, what would you 'lose' in order to accommodate it?

4.0 Research
- 4.1 What was your RAE rating at the latest assessment?
- 4.2 How much of the input to the assessment exercise was related to construction management?
- 4.3 Approximately, how much of the research carried out by members of your section/faculty/school has an environmental focus?
- 4.4 Does this research feed into teaching?
- 4.7 Do the research findings feed back into industry?
- 4.5 How much influence do you have over choice of dissertation topics?
- 4.6 Do you have any examples of best practice relating to the teaching of environmental subjects?

5.0 Barriers
- 5.1 What barriers (if any) prevent more concentration on environmental issues within the curriculum (e.g. time, staff expertise)?
- 5.2 Are staff willing/keen to develop material in this area?
- 5.3 Does the University have a policy for protecting the environment, and does this feed into the development of curricula?

6.0 The Construction Industry
- 6.1 How seriously do you think the industry takes sustainable construction issues?
- 6.2 Do you think the industry has a thorough understanding of the environmental impact of the built environment?
- 6.3 Do you think that the Universities have a role to play in educating the industry about these issues?

6.4 If yes, how do you think this could be best achieved?
6.5 How much do industry representatives influence your curriculum?

7.0 Future
7.1 Do you think that sustainability/environmental issues will become a more important aspect of the curriculum in the future?
7.2 Whose responsibility do you think it is to inform curriculum change?
7.3 What could fuel these changes

d.

1.1	1.2	1.3
Yes	1999	No
Yes	N?A candidate status	Course had been set up to satisfy old framework
Yes	1996	Yes-no more env.
Yes	1999	Minor-year on year, no more environmental
Yes	1997-due in2002	No-not to document but have to modules, more environmental
Yes	1999	No
Yes	1997	Not really, no more environmental
Yes	1999	Not as yet-are doing, no more environmental
Yes	2000	Just doing-no intention for more on Env.
Yes	2001	No
Yes	1998	No
Yes	1999	No-new member of staff with sus. Interest More level 3 option
Yes	1998	Module changes only
Yes	Feb.2000	Yes-complete review. No more env/sust though
Yes	1999	Yes, but did not change environmental content
Yes	1998	Introduced level 3 optional module-Sust. Construction
Yes	1999	Doing now-new module on sustainable construction
Yes	Nov.1999	No
Yes	1997	Yes

Yes	1999	No
Yes	2002-old framework	N/A-small increase
Yes	1997	New programme vaidation in May 2002-significant changes re: environmental

2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9
No	Yes	Mainly technology, but are going to include in mamangement	Yes-4th yearb tech.	Fragmented-nature of modularisation	1	Increases-level 4 have lectures	Yes- CE BS QS Bserv-4ty year project	Projects/groupwork
No	One lev.3 option only	Heritage and Conservation	Small amount in some modules	Fragmented-thematic throughout though	1st	Increases due to student awareness	RIBA/RICS/CIOB lectures together and projects at all levels	Visual approaches-seeing damage stimulates understanding
Yes-env.sot sust	Yes-env.only	Environmental Management 3 of 4 Bldg.+Env.services-3 of 4	C/W in previous	Fragmented	3 of 4	Same	Cross division degrees only-not popular	C/W and exam-same as all subjects
Not at prog level	Yes	Blt.Env.+Org,Man-level 4 Technology modules Con.Man. lev.3	Blt.Env.+Org, Man-level 4 modules Con.Man. lev.3	Integrated in certain modules only. No specific modules	3	No-same in lev 4	Yes very much CE/QS lesser Env.Man.	C/w as opposed to exams
Yes	Yes	DTM-1,2,3, Prod.Man 1,2,3 Con.Science 1, bldg.sc.-2 Bldg&the envion. –2 Con.Man. 3	Yes-waste management Photovoltaics	Integrated and IMPLIED in most subjects	1st	Increases	Definitely QS CM Arch CE	Interdisciplinary projects
No	Yes	Env. Law-2 Env.Science-1	Yes-see previous	Fragmented	2	Stays same	BS, QS	Case Studies
Yes	Yes	Con.Tech, Env.Sci, Services, Stat.control, Con.Economics, Development	No	Integrated in modules see 2.4. No specific modules	1	Same but focus changes 1-informing	Yes A.Tech.,BS,QS very much CE to Lesser extent	Formative-especially group projects

		studies etc.				students 3- adressing issues		
No	Env. yes, sust. no	Bldg Technology and Fabric Materialsx3 mods	No	Fragmented	2	Same	Common modules 5 diff.progs. One interdisciplinary project	Studios
No	Yes	Tech.-theme through all 4 years(thin sand.) Economics-EIA Strategic studies Services Project-level 3	Final year project suite, topic changes every year dependent on what is topical. Has been env.focussed approx.50%	Fragmented in the main	1	Same	No due to thin sandwich on CM programme only-impossible to timetable	Group projects, PBL
Yes	Yes	Science, Services and Technology-all levels Materials and sustainability-level 3 option	Only in specific options	Integrated mainly but there are specific modules	1	Increases	Yes-all progs. In School plus wprk with other Schools-	Doesn't know
No	Yes	Technology and Management	Yes	Integrated	1	Focus changes, more applied	Yes-QS/CM a lot, BS less so	Projects
Yes	Yes	Technology, Design module, design projects	Module called environmental considerations-total focus env. Issues, various level 3 and 2	Fragmented	Introduced level 1. Expanded level 2		Arch.Eng., CM, QS, BSEng., CE Taught together and do projects	Lectures deliver core information, case study projects

			options Lev. 1-into to industry includes env. Impact		Optio ns lev 3			
No	Yes	Bldg. Services and Env.Sci.-1 and 2 Bldg. Tech.1	No-Integrated into assessments	Predominantly integrated with some specialist lectures	1	Give info in level 1 More integrate d into subjects at levels 2 and 3	No- definitely not New programme does- joint teaching due to res. Constraints Intergated projects due to staff seeing benefits	Continual assessment- if it is a one of assessments students see it as a one off subject only
Yes- one of 30	Yes	Management issues(3) Technological innovation and life cycle(3) Interdiciplin.Issues(3 Interporf. Dev.project(2) Environment and con.Materials (1)	No	Fragmented	New revie w inclu des for themi ng of Env. Thor ugh prog. Not sure whet her it does thoug h	Increases- although changes Lev.1 knowledg e Levels 2 and 3 applicatio n of knowledg e	Very advanced 2500 students work together on projects in mixed groups Arch, planning, geag, Env.Man, BS, QS, RESurveying, CM CE ADT BuildingService s	Interdisciplinary approach-group projects
Yes	Yes most	Technology Services Law Envir.Impact of	Yes-a lot and all project modules	Both-outcomes in nearly all modules include green	All	Constant	Y- Surv. CE and archit.	Students give presentawtions on indepth

		buildings-a lot		issues-some totally				research topics
No	Only sustCon.level 3	NA	No- apart from S.C	Integrated-relevant modules mentioned in: Site management-2 Proj.Management-3 Con.Economics-2	2	Introduced in lev.2-can choose to specialise in levl.3	Joint Teaching Con.Tech.BS QS CM Joint project in level 2	Teaching con.tech. trough design modules-project based
Yes-but very general	No	N/A	included in all group work	Integrated	1	Constant	JointProjectsCE Arch BS QS 2nd and final year	Seminars and discussions
No	No	N/A	Some	Fragmented	1	Yes, slightly	No-used to with Arch.	C/work-research based
Yes	Technology & Design	Technology and Design	Environmental Design Exerc.	Fragmented	2nd	Increase	Y-Arch.& Surveying	Integrated Projects
No	Yes	IT and Communications-have core of lectures by externals on env. And sus. And then use as case studies in the IT assessments	Bldg. Env.Engineering But mainly pure building services	One module only integrated	1	decreases	No	Case studies
Yes	Yes	Construction and Design-level 3	Yes-previous module Mentioned in level 2 economics	Fragmented	2nd	Increases in level 3	Yes-CM,BS,ADTM have classes together. Final year int. project	C/work, seminars and presentations
Yes	Yes	Env.Sci., Const. And Environment, HSE Management for Construction	Yes	Both	Level 1	Increases	Y-CM,CE,A.Tech, Arch.Eng, BS, QS all going for CIOB exemption	Project based

3.1	3.2	3.3
No	Yes, and hopefully it will allow more flexibility to accomdate relevant changes	Integrtae more- only drop stuff when relvant
No	Curriculum full, therefore difficult	Don't know-need to everything they do already
Yes	Enough IN	N/A
Not really enough	Yes definitely	Probably straightforward Con.Tech.
Have to look hard to find	Not because of framework-will do anyway	
No	No	N/A
No	Yes-but would anyway	Trying to approach in different way-integrating more
No	Yes	Yes-probably materials
No-doesn't sell itslef well	No tested curriculum believe they have enough	Can't lose anything programme covers CIOB framework
No	Would develop further	Integrate further
No	Yes	Integrate more and change emphasis
No-but tried to integrate H&S as it is topical;	More flexile framework would allow for more-then yes	Fluid mechanics, language options
No	Yes, but-they will put it in anyway(10-15% of programme)	Yes-structures, heavy maths, labs-especially as resource issue, IT but students don't need as much cos they are coming in with better skills
Not explicit enough-energy efficiency only	SHE approach, so will increase automatically	No-taking SHE approach though. Stick with what got but encourage module leaders to put more emphais on in al modules
No	Yes	Nothing-just integrate more into all modules
Yes	Got enugh in-would put into level 3 if research funds available	N/A
Not specifically-but discussed at all acc. events	Yes-are doing	Reconfigure –not lose anything
No	Yes	Nothing-need to review whole course to make sure no duplication in modules
New one does	Not yet-time will tell	

Yes	No	N/A
No	Yes	Dificult to fit in especially at levels 2 and 3. Level 3 best place for it
Yes-theme but not specific	Yes	More integration of modules

4.1	4.2	4.3	4.4	4.5	4.6	4.7
5-same as 5* in England	10%	25%	Not as much as it should	Yes		No-but field visits sometimes focus on conservatiion iissues
3d	20%	60%	Yes mainly MSc though	No	Give 6 areas then they choose	Built 14 residential sustainable homes, sponsored by Industry, use by students as case studies
3a-Civils	None	None	no	No	List and encourage own choice	No
CM not involved		Some RAE4 for Env.Studies	Small amount from scientfic perspective	Some	Produce list-encourage students to choose own	Use of CIRIA resource pack
2b	Small amount	Significant-very high	Yes	Yes-collaborative partners	Free rein-benefit form guidance	Visits to recycling centres, lot of env. Site visits
3a	Very little-fire mainly	None	Yes-fire though	Yes-fire though	Do list, but encourage to choose their own	No
3b	Gen.Eng.group 1of 9	40% of that 1 person, 20% of 9	Very limited	Yes-funded by LA to consult of housing maintenance	Produce list-encourage students to choose own	No
4	25-33%	10-15%	Some of it	Not sure	Final decision only-would dissuade if repetative, no staff expertise	No

					and lack of student capability	
5*A	Approx. 70%	10-15%	Yes-a lot	Yes a lot	Free rein	No-but have a member of staff who is well recognised internationally who uses excellent global case studies
3a	30%	30%	Yes	Yes definitely	Some staff promote topics linked to their research-80% choose own	No
3a	25%	40%	Yes	Not so much	Fair amount- suggest topics, give list but also encourage	No
5*	90%	Unsure- but have major project on water management	Yes- a lot	Yes-a lot, most research industry commissioned and driven	Depends on student- provide lists but can choose own	No
4a	0%	Very small-5%	Yes-small way reflects on amount of research	Yes- industry sponsored projects	Student driven	No not really
N/A	Very little	50% mainly planning and housing	Not a lot for CM	Yes-mainly with LA contacts	Free rein, just say can't repeat what's already been done	Interdisciplinary projects(learning)
4e(Civil Eng.)	Some but little	In built env.-most	Yes	Yes, publications/CPD	A lot	
5	All of it	Less than 25%	Of course	All research published as practitioner material if possible	Choose own	No

3b	Very little	Main theme of research	Not enough-researchers don't teach	Yes-work with industry-collaborations	Students choose-they tell them what's topical	Bldg. Sust. Houses on campus-students will visit
N/A but section is slightly research active	None	None	To some extent	Small amount-work with one organisation only	Students choose- if no tutor available change topics. Lot on Env. Issues	Environmental Good Practice on site training pack bought and used.
2b	Very little	Not very much	Yes	No	Staff advise students	Some-contact c.i.frame@apu.ac.uk
5	Very little	25%	No	no	Free choice	See2.3
3b	25%	50%	Yes	Not directly-indirectly via curriculum	Free choice	No
3	70%	20%	Yes	Limited way	Do a list for guidance but can choose own	Run interdisciplinary project-designing energy efficient house

5.1	5.2	5.3
Modularistation	Yes	Yes and No
Time, curriculum congestion. Integration can either increase or reduce focus	Yes, younger staff mainly	Yes they do-green transport systems on campus, buying bikes for staff Con Man curr. Not directly influenced but indirectly. Students involved in the design of cycle lanes etc.
Necessity to cover other topics	Yes	No idea
CIOB framework, staff age- less able to change, movement of staff slow	As a whole not really, 1 or 2 individuals	No
None-if any competing topics	Yes-definately	Yes and No
Lack of expertise	No	Yes and not sure
Market itself not demanding it Expertise-staff moving to other HEIs with lot of env.knowledge	Yes	Yes –relate aim of course to Uni. Env. Strategy. Not as good as could be and only incoprtared into programmes

		where topic is relevant
Mainly not enough room in curriculum	Yes if their research interest	Yes-for development of own buildings Yes-has a suite(12) environmental modules that is encouraging all students on all programmes to take as options
None	Yes with time allowed	No and No
Time of staff, and lack of curr. Space cut curr. Down to need to know	Yes	Yes and No
None	Some-yes	No and No- but quite well embedded in the School
Lack of goc. Initiatives and legislation(needs top down integration), staff interest, professional bodies not prescriptive enough	Yes	Yes(greem policy for campus) and No
Yes if had time-if staff are developing new areas, they are so busy they would have to drop something to do	Yes if had time	No-recycles things, not in mission statement-NO to CD
Modular system, structure of Uni. Difficult to build staff teams with members from different faculties, so don't use their expertise in sust. Therefore there are limitations even in the interdiscpl. approach	Yes-time and staff interest. Technology lecturers have taken it on board. Man. Lects. Bring in specialists to deliver these lectures	Yes-mainly recycling, No-doesn't affect curriculum. New architecture building uses sust. Construction-faculty initiative supported by uni-not their initiative
Staff expertise generally-not a problem here though Prof. Body opinions	Yes	Don't think so-should have though
Time, staff expertise	Yes-if research funding available	No and No
None	Very willing-lot of money coming in in this area	No and No
No	Yes	Not aware
Time&Expertise	Yes	Yes and No
Staff perception-dpn't think builders need all that much, mainly designers	No, given above	If have not widely communicated, and no
Staff expertise, only small group of teaching staff	Yes, those who are interested	Yes and Yes-it will in the future
Staff interest, lack of space in curriculum	Some very keen, some less so.	No and No

6.1	6.2	6.3	6.4	6.5
At high management level they do as politically sensible, doesn't filter into on site activities	No	No but as individuals we have a responsibility to do-Unis don't provide vocational training	NA	Have sponsored course so yes, Have ind. EE and PLG
Know it's an issue-not prepared to pay for it	No-too much short termism	Yes- need to develop people as learners NOT just achieving our LOs	Money incentive. Putting oon seminara to disseminate best practice from global examples. Website development for information	Take notice of what they say, but only implement changes on the 5 year cycle
Only if £ involved	Yes	Yes	Curriculum and CPD	Industrial advisiry panel-not asked for more env.
Not a lot, only when pressed by clients, can do then e.g Newbury byepass	No, but beginning to work on it-cleint pressure, clients contacting Unis for info.	Yes	CPD, local CIOB committee, consultancy services	Yes, Ind.liaison group. Ind. Has blinkered views, want Unis. to teach skills Not academic subjects
Not seriously enough-policies no action	No-site managers automatically order new material instead of recycling fill for example	Yes and try to	Consultants/curriculum/ CPD	Take note of what ind.liaisin committee says change if agree with
Not very	No	Yes	Increased funding for research	No-mainly prof. Body(is this developed through industry?)
Big few do, rest no	Big few do, rest no	Yes	Formally included in building courses	Not a lot –but should
Not much	No	Yes	Consultancy/ CPD	Virtually none
Likes to think it does, but other things more improtant	No, very superficial	Yes	Workshops, CPD	They have an input, not full say. Take the approach that you have to balance what academia can provide and what industry and P.Body want
Some parts do, good	Some parts- examples of	Yes	CPD	Ind.liaison comm..

examples of good and bad practice	sus. Construction being used and life cycle issues as well			informs them but don't have any real input. Nd. Want more on skills development- reduce content
Minority do	No	Definately	Curriculum-to change balance from inside industry, long term process	10%
It doesn't	No	Yes-but if university driven, industry won't pay	Collaboration approach-uni.expertise, industry funding Provision in bldg regs. Either or options see sheet	Industry sponsored, 13 intern. Contractors, have strong input but not as great as the CIOB-industry happy with curr. And haven't pushed env.
www.apt-env.co.uk only interested in env. If improves bottom line	No	Yes-thro curriculum	Integrated but not specific on Env. Needs to be related to all other areas-integrtared approach	Directly-very lillte Indirectly-staff involvement in best practice club
50% nominally 25% don't 25% don't know about it	No-too production orientated Architects and engineers more so	Yes	Degree programmes, acting as consultants-utilising research	Access to talking shop, when they bring uop envir. Maybe they will change curr.
In theory yes, in practice no	Definitely no	Definitely yes-subject to resources constraints	CPD/PG Dip opportunities	A lot-industry strongly supports their environmental ethos
Takes it seriously where financila imperative-what has pushed it has been the increased use of PFI contractors nore interested in whole life now	No- never had to think about it before	Yes	Curriculum-ALL universities, at Reading, gov. funded research	Not at all
Usually client driven-2nd to financial	Not really	Very much	Instill a culture of sustainability in students, CPD ,papers	Employer panel, discuss curriculum but academics make final decisions

Large contractors yes, smaller ones no	Probably not	Yes	Integrate env.issues more in university courses	Very little-main inflience CIOB
Not as seriously as it should	Not as much as it should	Yes	Joint research and teaching programmes	A lot via employer groups
Not very high	No-market driven	Possibly given a different environment. Universities are market driven also an do what industry wants	Curriculum-slow process for long term effects Industry doesn't listen to academia	Not a lot, only when review near
Not at all	No	Yes	curriculum	Quite a lot, don't advise more of envir. More on transferable skills
Not very-increasing slightly	Not very well but increasing slightly	Yes	Curriculum primarily	Ind. Liason group and feedback from part time students thro BoS as to what is relevant

7.1	7.2	7.3
Yes	Academics-course leaders mainly	Society in general
Awareness of younger students to env.issues will lead to more emphasis being placed on the area.	Clientsthey have the moneyy	Industry suffering from initiative fatigue. Needs to come from clients and students.
Possibly	PB/Academia/academics	Legislation
Yes	Acedmics mainly, feedback from Industry CIOB hasn't got systems in place to lead.F/work provides blanket coverage	Pressure from contractors as they are now having to include env.policies in tender documents.
Yes	Academia	Combination but mainly government initiatives
Yes	Government	Through industry
Yes	1st-Government, 2nd prof,bodies	Major clients(including gov.) requiring staff with more expertise
Yes	CIOB	Gov. pressure and legislation
Yes- increasingly especially P.Grad	Government-but someone needs to force them to make changes	Legislation
Yes	Academics have to find out what is important from industry and the PB	Increased use of benchmarking

	and then change curr.	
Yes	Academics	Academic refocussing- thinks next CIOB visit will see it as a priority
Yes	Government inititaive such as Latham and Egan, prof.bodies	Gov. initiaties, natural disaster linked to env. Issues
Yes	Academics-advising undergraduates Students-schools will developing more knowledge	If could sell a programme would do it tomorrow Legislation
Yes- even though they have aims in programme, needs to be shown in module outcomes	Government and European Parliament	Initiatives like Egan. Work by CIC, CIRIA, CRISP etc.
Definitely	All-students, HE indurty, prof.bodies	Law, supply and demand
Yes-client driven	Universities should tell industry what they need	Gov. funded resaerach would get into curriculum
Yes	Academics, researchers, employers and CIOB	Pressure from P.B.
Yes	CIOB and industry to design, academia to implement	Legislation mainly, but industry is staring to find out about best practice and implement
Yes	Academics/Industrialists	Government Initiatives and students
Yes-when it becomes economically viable	P.Body/Industry-univresities will react as opposed to being proactive	Legislation
Yes	PBs/Industry/Academia	Gov.Policy
Yes-definitely	Educ, PB Industry Gov. everyone	Legislation-unfortunately

e.

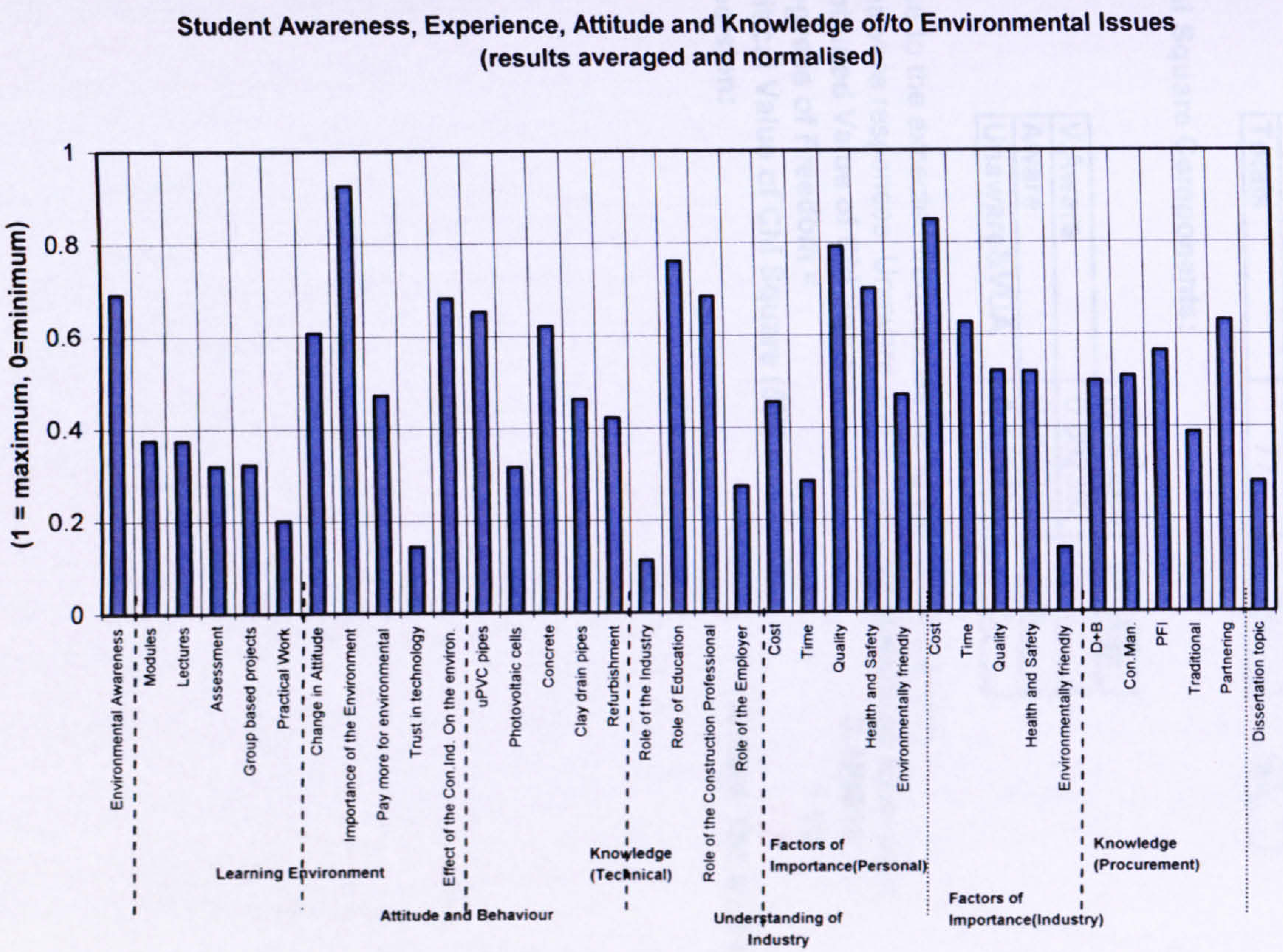
	1		2a	2b	2c	2d	2e	3a	3b	3c	3d	3e	4a	4b	4c	4d	4e		5	6
Very aware	28	100%	4	2	1	2	1	37	126	19	5	69 naging	25	4	19	1	5	Yes	17 portant	57 portant
Aware	110	75%	21	18	10	18	9	74	18	54	14	37 naging	59	20	55	29	27	No	134 portant	82 portant
Unaware	13	50%	38	40	41	38	18	20	8	52	23	32 verage	52	28	60	76	56	ɔ Entry	2 portant	14 portant
Very Unaware	2	25%	73	87	80	60	51	22	0	28	111	15 Good	13	50	14	37	44		Very Unimportant	0 portant
No entry	0	0%	16	6	21	35	68	0	1	0	0	0 / Good	2	42	3	8	20		No Entry	0 ɔ Entry
			1	0	0	0	6					No Entry	2	9	2	2	1			
Weighted Sum	105.7		57	57.25	49	49.5	29.5	93	140.7	72.33	22	104.3 d Sum	98.5	45.5	93.75	70	64.25		17 d Sum	116.3
Number of Entries	153		152	153	153	153	147	153	152	153	153	153 Entries	151	144	151	151	152		151 Entries	153
Average Mark	0.691		0.375	0.374	0.32	0.324	0.201	0.608	0.925	0.473	0.144	0.682 e Mark	0.652	0.316	0.621	0.464	0.423		0.113 e Mark	0.76
Full Title																				

7		8	9a	9b	9c	9d	9e	10a	10b	10c	10d	10e	11a	11b	11c	11d	11e	12
36	Yes	41 High-1	18	11	81	53	21	106	24	13	22	7	30	15	34	24	48	42
92	No	109 High-2	37	14	33	42	28	23	65	34	27	7	26	32	38	21	35	107
22	ɔ Entry	3 ·rage-3	23	23	24	34	47	6	32	61	48	9	34	56	28	18	26	4
3		Low-4	46	40	10	17	24	8	23	41	49	16	26	32	28	33	21	
0		Very Low-5	27	63	4	5	32	8	7	3	5	112	30	12	20	51	17	
		No Entry	2	2	1	2	1	2	2	1	2	2	7	6	5	6	6	
104.7		41 d Sum	68.75	43	120.3	105.8	71.5	128.3	94.5	79.25	78.5	20.75	73	75	83.5	57	92.5	42
153		150 Entries	151	151	152	151	152	151	151	152	151	151	146	147	148	147	147	149
0.684		0.273 e Mark	0.455	0.285	0.791	0.7	0.47	0.849	0.626	0.521	0.52	0.137	0.5	0.51	0.564	0.388	0.629	0.282

Awareness	Environmental Awareness	0.69
Exposure to envir.issues	Modules	0.38
	Lectures	0.37
	Assessment	0.32
	Group based projects	0.32
	Practical Work	0.2
Attitude	Change in Attitude	0.61
	Importance of the Environment	0.93
	Pay more for environmental	0.47
	Trust in technology	0.14
	Effect of the Con.Ind. On the environ.	0.68
Knowledge(Technical)	uPVC pipes	0.65
	Photovoltaic cells	0.32
	Concrete	0.62
	Clay drain pipes	0.46
	Refurbishment	0.42
Role of Parties	Role of the Industry	0.11
	Role of Education	0.76
	Role of the Construction Professional	0.68
	Role of the Employer	0.27
Importance of factors	Cost	0.46
Personal	Time	0.28
	Quality	0.79
	Health and Safety	0.7
	Environmentally friendly	0.47
Importance of factors	Cost	0.85
Industry	Time	0.63
	Quality	0.52
	Health and Safety	0.52

	Environmentally friendly	0.14
Knowledge(Management)	D+B	0.5
	Con.Man.	0.51
	PFI	0.56
	Traditional	0.39
	Partnering	0.63
Dissertation	Dissertation topic	0.28

f.



Student Awareness, Experience, Attitude and Knowledge of/to Environmental Issues
(results averaged and normalised)
(1 = maximum, 0=minimum)
1
0.8
0.6
0.4
0.2
0
Environmental Awareness
Modules
Lectures
Assessment
Group based projects
Practical Work
Change in Attitude
Importance of the Environment
Pay more for environmental
Trust in technology
Effect of the Con.Ind. On the environ.
uPVC pipes
Photovoltaic cells
Concrete
Clay drain pipes
Refurbishment
Role of the Industry
Role of Education
Role of the Construction Professional
Role of the Employer
Cost
Time
Quality
Health and Safety
Environmentally friendly
Cost
Time
Quality
Health and Safety
Environmentally friendly
D+B
Con.Man.
PFI
Traditional
Partnering
Dissertation topic
Learning Environment
Attitude and Behaviour
Knowledge (Technical)
Understanding of Industry
Factors of Importance(Personal)
Factors of Importance(Industry)
Knowledge (Procurement)

g. Chi Square 1

CHI SQUARE CALCULATION TEMPLATE:

Observed frequencies:

Awareness	Programmes With Aim	No Aim	Totals
V.Aware	14	14	28
Aware	55	55	110
Unaware&VUA	8	7	14
Totals	77	76	152

Expected frequencies:

	With Aim	No Aim	Totals
V.Aware	14.18421	14	28.18421
Aware	55.72368	55	110.7237
Unaware&VUA	7.092105	7	14.09211
Totals	77	76	153

Chi Square Components:

	With Aim	No Aim
V.Aware	0.002392	0
Aware	0.009398	0
Unaware&VUA	0.116224	0

Due to the expected frequencies being too low in the Very Unaware responses. Unaware and V.Unaware responses have been

Obtained Value of Chi Square = **0.128015**
Degrees of Freedom = 5.99
Critical Value of Chi Square (5%) = **7.8**
Decision: **Accept The Null Hypothesis**

h.

One Sample Z test template: Z Test 2

Raw data:

Data at top of page 6:

X	100	75	50	25	0	
frequency	1	10	41	80	21	153
						Totals
f*x	100	750	2050	2000	0	4900
f*x*x	10000	56250	102500	50000	0	218750

Mean =	32.02614
SD =	20.10136
SE(est) =	1.630436
Hypothesised value =	16
Z value =	9.829363
Critical Value (one-tailed - 5%) =	1.645
Critical value (two-tailed - 5%) =	1.96

Reject one-tailed
Reject two-tailed

In this case, the average percentage of assessment (32%) is significantly greater than that perceived by the programme leader (16%)

Table - 9.2.4.3

X	100	75	50	25	0	
frequency	2	18	38	60	35	153
						Totals
f*x	200	1350	1900	1500	0	4950
f*x*x	20000	101250	95000	37500	0	253750

Mean =	32.35294
SD =	24.73427
Coefficient of variation =	76.45137

Latter shows a wide variation in student perception for the variable in question
The mean value of 32% confirms observation that student perception of

i.
One Sample Z test template: Z Test 1

Raw data:

X	100	75	50	25	0	
frequency	0	7	33	70	20	130
						Totals
f*x	0	525	1650	1750	0	3925
f*x*x	0	39375	82500	43750	0	165625

Mean =	30.19231
SD =	19.03846
SE(est) =	1.676243
Hypothesised value =	16
Z value =	8.466736
Critical Value (one-tailed - 5%) =	1.645
Critical value (two-tailed - 5%) =	1.96

Reject one-tailed
Reject two-tailed

In this case, the average percentage of assessment (30.2%) is significantly greater than that perceived by the programme leader (16%)

X	100	75	50	25	0	
frequency	0	12	30	54	34	130
						Totals
f*x	0	900	1500	1350	0	3750
f*x*x	0	67500	75000	33750	0	176250

Mean =	28.84615
SD =	22.88381
Coefficient of variation =	79.33053

Latter shows a wide variation in student perception for the variable in question
The mean value of 29% confirms observation that student perception of

j. ChiSqProc

CHI SQUARE CALCULATION TEMPLATE:

Design and Build

Observed frequencies:

D+B	HR	LR	Totals
ME	16	14	30
E	9	17	26
A	16	18	34
NE	16	10	26
VEF	13	17	30
Totals	70	76	146

Expected frequencies:

	HR	LR	Totals
ME	14.38356	15.61644	30
E	12.46575	13.53425	26
A	16.30137	17.69863	34
NE	12.46575	13.53425	26
VEF	14.38356	15.61644	30
Totals	70	76	146

Chi Square Components:

	HR	LR
ME	0.181657	0.167316
E	0.963556	0.887485
A	0.005572	0.005132
NE	1.002017	0.922911
VEF	0.133085	0.122579

Obtained Value of Chi Square = **4.391309**
Degrees of Freedom = 4
Critical Value of Chi Square (5%) = **9.5**
Decision: **Accept The Null Hypothesis**

Construction Management
Observed frequencies:

CM	HR	LR	Totals
ME	7	8	15
E	18	14	32
A	28	28	56
NE	13	19	32
VEF	4	8	12
Totals	70	77	147

Expected frequencies:

	HR	LR	Totals
ME	7.191781	7.808219	15
E	15.34247	16.65753	32
A	26.84932	29.15068	56
NE	15.34247	16.65753	32
VEF	5.753425	6.246575	12
Totals	70.47945	76.52055	147

Chi Square Components:

	HR	LR
ME	0.005114	0.00471
E	0.460323	0.423982
A	0.049315	0.045422
NE	0.357644	0.329409
VEF	0.534377	0.492189

Obtained Value of Chi Square = **2.702486**
Degrees of Freedom = 4
Critical Value of Chi Square (5%) = **9.5**
Decision: **Accept The Null Hypothesis**

PFI

Observed frequencies:

PFI	HR	LR	Totals
ME	20	14	34
E	14	24	38
A	15	13	28
NE	14	14	28
VEF	8	12	20
Totals	71	77	148

Expected frequencies:

	HR	LR	Totals
ME	16.30137	17.69863	34
E	18.21918	19.78082	38
A	13.42466	14.57534	28
NE	13.42466	14.57534	28
VEF	9.589041	10.41096	20
Totals	70.9589	77.0411	148

Chi Square Components:

	HR	LR
ME	0.839185	0.772934
E	0.977073	0.899935
A	0.184862	0.170267
NE	0.024658	0.022711
VEF	0.263327	0.242538

Obtained Value of Chi Square = **4.397489**
Degrees of Freedom = 4
Critical Value of Chi Square (5%) = **9.5**
Decision: **Accept The Null Hypothesis**

Traditional

Observed frequencies:

Trad	HR	LR	Totals
ME	15	9	24
E	10	11	21
A	5	13	18
NE	12	21	33
VEF	28	23	51
Totals	70	77	147

Expected frequencies:

	HR	LR	Totals
ME	11.50685	12.49315	24
E	10.06849	10.93151	21
A	8.630137	9.369863	18
NE	15.82192	17.17808	33
VEF	24.45205	26.54795	51
Totals	70.47945	76.52055	147

Chi Square Components:

	HR	LR
ME	1.060421	0.976703
E	0.000466	0.000429
A	1.526962	1.406413
NE	0.923217	0.850331
VEF	0.5148	0.474158

Obtained Value of Chi Square = **7.733899**
Degrees of Freedom = 4
Critical Value of Chi Square (5%) = **9.5**
Decision: **Accept The Null Hypothesis**

k.

ChiSq2

CHI SQUARE CALCULATION TEMPLATE:

Observed frequencies:

	FT	PT	SW	Totals
Yes	9	3	5	17
No	56	25	54	135
Totals	65	28	59	152

Expected frequencies:

	FT	PT	SW	Totals
Yes	7.269737	3.131579	6.598684	17
No	57.73026	24.86842	52.40132	135
Totals	65	28	59	152

Chi Square Components:

	FT	PT	SW
Yes	0.411818	0.005529	0.387318
No	0.051859	0.000696	0.048773

Obtained Value of Chi Square =	**0.905993**
Degrees of Freedom =	2
Critical Value of Chi Square (5%) =	**6.0**
Decision:	**Accept The Null Hypothesis**

I.

ChiSq4

CHI SQUARE CALCULATION TEMPLATE:

Observed frequencies:

	FT	PT	SW	Totals
Yes	18	7	16	41
No	47	21	42	110
Totals	65	28	58	151

Expected frequencies:

	FT	PT	SW	Totals
Yes	17.64901	7.602649	15.74834	41
No	47.35099	20.39735	42.25166	110
Totals	65	28	58	151

Chi Square Components:

	FT	PT	SW
Yes	0.00698	0.047771	0.004021
No	0.002602	0.017806	0.001499

Obtained Value of Chi Square =	**0.080679**
Degrees of Freedom =	2
Critical Value of Chi Square (5%) =	**6.0**
Decision:	**Accept The Null Hypothesis**

m. ChiSq5

CHI SQUARE CALCULATION TEMPLATE:

Observed frequencies:

	PT	FT	SW	Totals
YVM	7	13	17	37
YBNM	14	34	27	75
Maybe	4	8	8	20
No	3	12	7	22
Totals	28	67	59	154

Expected frequencies:

	PT	FT	SW	Totals
YVM	6.727273	16.0974	14.17532	37
YBNM	13.63636	32.62987	28.73377	75
Maybe	3.636364	8.701299	7.662338	20
No	4	9.571429	8.428571	22
Totals	28	67	59	154

Chi Square Components:

	PT	FT	SW
YVM	0.011057	0.595991	0.562865
YBNM	0.009697	0.057532	0.104614
Maybe	0.036364	0.056523	0.01488
No	0.25	0.616205	0.242131

Obtained Value of Chi Square =	**2.557856**
Degrees of Freedom =	6
Critical Value of Chi Square (5%) =	**12.6**
Decision:	**Accept The Null Hypothesis**

n. ChiSq6

CHI SQUARE CALCULATION TEMPLATE:

Observed frequencies:

	PT	FT	SW	Totals
YVM	24	53	50	127
YBNM&Maybe	4	13	9	26
Totals	28	66	59	153

Expected frequencies:

	PT	FT	SW	Totals
YVM	23.24183	54.78431	48.97386	127
YBNM&Maybe	4.75817	11.21569	10.02614	26
Totals	28	66	59	153

Chi Square Components:

	PT	FT	SW
YVM	0.024732	0.058115	0.021501
YBNM&Maybe	0.120807	0.283868	0.105023

Obtained Value of Chi Square =	**0.614046**
Degrees of Freedom =	2
Critical Value of Chi Square (5%) =	**6.0**
Decision:	**Accept The Null Hypothesis**

o. ChiSq7

CHI SQUARE CALCULATION TEMPLATE:

Observed frequencies:

	PT	FT	SW	Totals
Definitely	2	12	5	19
Probably	10	24	20	54
Maybe	9	18	26	53
No	7	13	8	28
Totals	28	67	59	154

Expected frequencies:

	PT	FT	SW	Totals
Definitely	3.454545	8.266234	7.279221	19
Probably	9.818182	23.49351	20.68831	54
Maybe	9.636364	23.05844	20.30519	53
No	5.090909	12.18182	10.72727	28
Totals	28	67	59	154

Chi Square Components:

	PT	FT	SW
Definitely	0.61244	1.686501	0.713654
Probably	0.003367	0.010919	0.022901
Maybe	0.042024	1.109695	1.597168
No	0.715909	0.054953	0.693374

Obtained Value of Chi Square = **7.262905**
Degrees of Freedom = 6
Critical Value of Chi Square (5%) = **12.6**
Decision: **Accept The Null Hypothesis**

p. ChiSq8

CHI SQUARE CALCULATION TEMPLATE:

Observed frequencies:

	FT	PT	SW	Totals
Def+Prob	10	4	5	19
Maybe	12	6	5	23
No	45	18	49	112
Totals	67	28	59	154

Expected frequencies:

	FT	PT	SW	Totals
Def+Prob	8.266234	3.454545	7.279221	19
Maybe	10.00649	4.181818	8.811688	23
No	48.72727	20.36364	42.90909	112
Totals	67	28	59	154

Chi Square Components:

	FT	PT	SW
Def+Prob	0.363641	0.086124	0.713654
Maybe	0.397149	0.790514	1.648829
No	0.285109	0.274351	0.864599

Obtained Value of Chi Square =	**5.423971**
Degrees of Freedom =	**4**
Critical Value of Chi Square (5%) =	**9.5**
Decision:	**Accept The Null Hypothesis**

q. ChiSq9

CHI SQUARE CALCULATION TEMPLATE:

Observed frequencies:

	PT	FT	SW	Totals
Def	11	32	26	69
Prob	7	17	14	38
Maybe	7	11	14	32
No	3	7	5	15
Totals	28	67	59	154

Expected frequencies:

	PT	FT	SW	Totals
Def	12.54545	30.01948	26.43506	69
Prob	6.909091	16.53247	14.55844	38
Maybe	5.818182	13.92208	12.25974	32
No	2.727273	6.525974	5.746753	15
Totals	28	67	59	154

Chi Square Components:

	PT	FT	SW
Def	0.190382	0.130664	0.00716
Prob	0.001196	0.013222	0.021421
Maybe	0.240057	0.613309	0.247028
No	0.027273	0.034432	0.097036

Obtained Value of Chi Square = **1.62318**

Degrees of Freedom = 6

Critical Value of Chi Square (5%) = 12.6

Decision: **Accept The Null Hypothesis**

Phase 2

r.

1.How long have you worked in education?
2.What was your experience in industry?
3.Do you have a specific research interest?
Want to talk about the curriculum of CIOB accredited programmes
4.How many courses are accredited by them?
What are they?
5.Number of students on CM course
6.Demand for the programme(s)?
7.Are they mixed with other groups?
8.Does this have positive or negative effects?
9.How are environmental issues incorporated into your curriculum?
10.Where in the curric are they appearing?
11.Are you happy with the extent to which the environmental issues are incorporated?
12.Fragmented or Integrated approach? How do you know?
14.In the professions that your graduates will be employed in, what are the main things that students need to know after completing their degree, from an environmental perspective?
Should their knowledge be:

- Generic or specific...15
- About Sustainability generally...16
- About Sustainable development, that includes social issues 17.........
- Focus on Sustainable design 18.........................
- Focus on Sustainable construction 19

20.Will this knowledge enable real changes to be made to industry practices? Why?
21.What are the students' attitudes to the inclusion of environmental issues within the programme?
22. Do attitudes change as they progress through the course?
23. How do you know this Is there any evidence?
25.Is there anything that prevents more inclusion?
26. Are you happy with the amount?
27.How does your curriculum develop?
Do you agree or disagree with the following, why and do you have any examples:
281.You develop Expected Learning Outcomes and then develop level outcomes, and then module outcomes?
282.The curriculum is generally Input driven?
283.Industry has a lot of influence on curriculum content?
284.The IOB framework is the main influence on the curriculum?
285.Staff research interests influence the curriculum
29.'Where in your curriculum is the dev of env literacy most strongly promoted?
30.What are the elements of curriculum design that you think best promote the development of environmental literacy? – interdisciplinary projects, problem based learning etc.
31.'What have been the most powerful influences on the curriculum content we have been discussing, with regard to the inclusion of environmental issues?
32. What do you see as the possible major curriculum changes in the future and why?
33. How would you rank the following on a scale of 1 to 5 regarding potential influence on the curriculum in the future:
EU parliament, UK government, Local government, CIOB, Industry, University itself, Staff, Students
For the following definitions do you agree strongly, agree, disagree, disagree strongly and why?
341. Sustainable construction is just a fad, hence it will go out of fashion so there is not much point in us focussing on it too much
342. Utilising sustainable construction techniques is not something that industry is really interested in so we don't need to worry too much about it
343.The main reason that industry doesn't 'green itself is because it will cost them money to set up EM Systems. However maybe in the future more clients will be asking questions about the environmental performance of contractors
344.Sustainability and environmental issues are of vital importance in the construction industry because of the impact that construction work has, so it is of vital importance that our students know about these issues
345. Sustainable construction is simply good management, what's all the fuss about, teach students to be good managers and they will utilise these principles in their everyday work

s. Phase 2 abortive manual coding for Q1

UK

How are environmental issues incorporated into your curriculum?
In the past I would say that they worked very little except you would have the very traditional environmental science at level one which was really the daylight factor, the siting of radiators that led into the building services at level two which was again lifts and all the rest of it and to call it environmental was a bit of a mis description. Now, as environmental issues are becoming much more of a concern in the country and in the industry it is tending to feature a lot more within modules. For instance in construction technology at level 3 they look at demolition and the environmental issues with regard to demolition. A nice article just out in the construction information service, the CIOB thing about environmental issues. They will do it with me in construction management modules if we are looking at materials management, particularly say we will be looking at waste, in the past we would look at it with the focus of if it is costing money, now we tend to look at much more with the focus that it is environmentally wrong, it is costing us a fortune to dispose of material that shouldn't have been wasted – we are paying for it twice, three times. So it is growing certainly in those modules. We have got some new courses that have just been validated that are coming in and we have actually incorporated it more, we have got a professional ethics module at level three where it will feature the safety issues and environmental issues and professional issues will be more important. We are trying to keep as all courses do. It is the focus of putting it into the modules rather than do it separately, it is integral rather than this module is on that. It is something we have always done with safety we have always said every module needs to look at it although on new courses we have put in a specific risk analysis module, but that is more than just safety so we still stick to the principle of trying to spread it into the modules.

Um, depends what you mean by environmental issues – if you mean the environment as noise, air all these sorts of things as the scientific side, it is simply covered in the scientific subjects and it will also be brought in technology this is how you cope with thermal insulation or sound insulation or whatever but that's the way it has always been. If by environment we then start talking about safety issues, sociological issues, these are principally brought in in the management subjects and a lot of it comes in because we are mixing with other courses. For instance if they choose to take as an elective some subjects with the estate managers they will do quite a lot to do with the social economic environment if that's what you mean by environment and they will do a lot of stuff that in the past we would have considered was a construction management but if they choose to do those subjects, then they will, but I mean safety, health and safety which is a big issue at the moment, we probably do more than most places. I mean one of my modules in the third year called site establishment and planning, 50% of that is to do with scaffolding and access and accidents and that sort of thing and then in the fourth year they have one module which is not compulsory but all construction management students take it because I lean on them to take it and that is to do with legislations, so they go through all the safety legislation and risk assessment and this sort of stuff so the third year one is the practical bit to do with scaffolding and access, excavations all this sort of stuff and the fourth year one which is taken by somebody else is all just goes through all the legislation is a bit, could be dry but Sam's very good at it and has actually the contract to teach the health and safety executive course, their diploma course, its worth a million a year to us, they will come here, Sam teaches on that so Sam is very much into legislation. I do not know if I can say much more about it, as I say we have not got many modules, any modules that are called the environment.

Environmental issues are generally introduced by individual modules so for instance construction technology modules will introduce environmental issues across a whole range of things. Some are looking at a particular choice of materials or a particular element of a building then along with time cost, quality, health and safety issues then the environment is also considered. They are probably more considered in building services modules to do with energy loss, heat gain and that sort of thing. More specifically we have actually got modules which are solely dedicated to the environmental aspects

There are a fair size of modules with about 20 points at Level 3 which is very much looking at environmentalism but very wide in terms of not just looking at waste management within construction companies but the re-use of buildings and the environment generally. Other than that, that is the only module that is specifically targeted towards it. It is just people – some of my colleagues – that have got an interest in waste, who will bring that into their lectures, the same way you bring in maybe a bit of costing into the technology, you bring in some waste environmentalism into the technology. You've got people looking at green rooms and we bring that in as part of their delivery into house design or something like that. It is really in parts of the syllabus, but there is only one module. We don't monitor it, a lot of people have got their interest so they are putting that in. It is not as clearly identified as may be it could – you would have to trawl through it to find it.

Well, I would say they are threaded all the way through the course. So, I would think you would find obvious outcomes regarding the environment and where they are not in, then they are brought in by the individuals. That comes from the old CIOB threads of the old educational framework. They had four themes that were supposed to run through the course and these are environmental, health and safety, quality, R and equal opps but environmental is sort of our theme. It comes in almost accidental routes as well, for example design economics.

My perception is that they are not incorporated enough. There are elements of sustainability and environmental issues in a number of units but whether there is a coherent sense of sustainability that is held by the student s I would not claim that, no I don't think they are getting that. Now interestingly when our School, because our current School is a combination or urban and regional studies and construction, when it came together one of the core themes was that green issues and sustainability should be key issues. And I don't think that has been achieved realistically. There are elements within the construction technology with materials within management, construction management I talk about sustainability but I don't think it's got a very high profile at all.

OK. So I'm now going to ask you some questions about environmental issues. How they are incorporated into your curriculum. Erm. So the question is. How are environmental issues incorporated into your curriculum erm and where are they appearing, so really that's what subjects would you expect them to do. DH This is were I need to ask you a question. What you mean by environmental issues? You need to give me some examples. AC Erm construction technology, erm, erm, quite a lot of people teach about, erm, sustainable design in construction technology. In management subjects I'll teach the environmental effects of particular procurement routes erm, materials, erm, it could be delivered in there. Erm, Economics. DH So it's from renewable resorts. Timber, that sort of thing. AC Yes. But it also has a management connotation as well. DH OK. I teach for example. I generally teach quantity surveying and management related issues. I don't teach construction technology. I am not, erm, I, I, have difficult to find the issues that you've just described erm, in the brief that I have in front of me here.

That's a big question. I would say that they are integrated into different modules and when I was thinking about you coming I would have thought there was probably two or three main modules where there is significant input, but quite often there is up to five courses in the year where there is some sort of input and I couldn't see any single place where it comes up – there isn't a single place – and actually the writing is very poor as well so documentation-wise we are badly covered, but in actual fact we are doing a lot more than we think.

So it is definitely very much an integrated approach:
It is an integrated approach, but it is not integrated by the Centre, it is just integrated by, I think, individual modules concerned to involve it. There isn't a particular path which is says you must have this. It is when you get down to detail you can see than there is some involvement

Australia

How are environmental issues incorporated into your curriculum?

I think they are incorporated throughout the program. There's certainly environmental elements that are specific in certain parts of the program. I mean our program here is very different if you have heard about it already but we use problem based learning, we don't use traditional lectures. Everything is based upon a problem and within that problem we have five study areas. I'm sure we can give you something to that to show that. We have Technology; Management, Economics, Communication and we have Ethics and Principals as well as another area. So in each phase of the program student's tackle a problem that has elements of those five things in it. So it integrates those things together. So I guess probably most of the Environmental aspects would be covered under the Technology heading although perhaps some of the Ethics and Principals given some of the legislation and things would be covered under that area. So that would be a general theme probably throughout the whole program but there are certain phases of the program that do have a significant focus on environmental factors.

Not very good in the few years, past few years, although it's since last year it is gradually on the agenda and we are introducing a few initiatives. I mentioned to you this subject that I am going to run called SmartXXX Sustainable Construction. That's a dedicated subject in this area although we have a few other subjects. For example Construction 1. And also Professional Studies 2 and 3 which has an element to reflect the environmental issues, sustainability outcomes of construction. But its not dedicated subjects its part of it.

We have Sustainability as a separate, we have two 6 credit point subjects if you like, which all of ours are 12 credit points so there's two half subjects and one is sustainability, the other one is housing, or Ecology OK and we cover it that way. But more and more now instead of trying to keep it as a separate subject per sa we are trying to incorporate it into other subjects. For example with materials, starting to put more of the sustainability in to itself instead of trying to keep it as a separate thing. Because I think it was a, to be honest probably three or four years ago it was the catch phrase of the year you know sustainability you know everything's got to be sustainable. But now we are trying to amalgamate it in to everything so it is not treated as a separate entity.
So you are moving towards and integrated approach as opposed to fragmented.
Yes, yes.

I was hoping you weren't going to ask that question because I don't teach any subjects that have an environmental component and the one time I did I was told I was doubling up with some content of another subject so the answer to that question is I'm not sure.

Its probably difficult to point out exactly where it is. If you went through the subject statement and looked for the word environmental or so on that's probably hard to find. But on the other hand it kind of infiltrates everything that they do. In first year construction for example students do what they call The Housing Studies they find the house that's about to start construction and they follow that and document that and the whole construction subject includes things like orientation on the site which has to do with energy and environmental issues and so on. Two final years this integrated project that I mentioned which is a realistic project that one of the local councils has the problem with and the students help them come up with the proposal of how to solve that problem. And of course that includes everything including environmental issues, public concerns, anything. All those issues that the council deals with. We have one subject which is Construction Science 3 which has to do with building energies. One of my colleagues Steve Poland is very much in to embodied energy and those kind of things. So he spends a lot of time looking at embodied energy and running energies and how that works in commercial buildings in particular.

They are only touched on and I would think in some ways it's a real weakness in our course. We just basically introduce them to Heritage Issues and also it turns up in Waste Management and trying to reduce it. But we don't have a significant component in that area.
Right so.
So ask the question again.
How are they incorporated in to the curriculum or where in the curriculum are they appearing.
There are probably 4 lectures that I could identify involves where I deal with those issues. They are in the Management area.

Environmental Issues are incorporated in explicit ways in various subject areas. For example we have a subject called Building Environmental Science – a first year subject. We have a subject called Building Environmental Services – true that is concerned with engineering, building engineering services but there would be. In each of those cases there's a strong thrust to environmental type of issues. Then you've got your other more orthodox type subjects like just Construction Technology itself and then even my own subject which at the moment is Construction Measurement and Estimating. In all the subjects lecturers are charged with wherever relevant trying to bring out the environmental issues. You know so in Technology a lecturer would be looking to identify which types of construction, which types of construction materials are actually more environmentally sound than others, all those sorts of things. Then they can choose to do a subject called Building Cost Planning where they would be involved in topics like life cycle costing and life costing. Perhaps, perhaps its relevant to say that in those subject areas of Building Environmental Science and Building Environmental Services that the two staff members who are involved in those subjects, on the front-line as you might say, they are also the two major players in the school in terms of research in to these areas.
Curtin
They are fully integrated into the programme, but obviously appear more in certain subjects like technology and management. This is an approach that we adopted because you have to remember a lot of the work carried out researching the impact of construction in the environmental impact of construction has been done in Australia.

t.

Phase 2 Quantitative data summary

Ranking of influence on curriculum 1=high, 5=low (UK)

	I1	I2	I3	I4	I5	I6	I7	I8	
University	1	1	2	2	3	1	1	3	14
CIOB	1	2	2	3	1	2	2	2	15
UK government	2	3	4	3	5	4	5	2	28
Local government	2	4	4	3	5	4	3	4	29
Staff	2	2	1	2	2	2	2	2	15
EU parliament	4	3	5	2	5	4	5	2	30
Industry	5	2	1	3	4	1	4	2	22
Students	5	4	1	3	5	2	1	3	24

UK

	I1	I2	I3	I4	I5	I6	I7	I8	
University	1	1	2	2	3	1	1	3	14
CIOB	1	2	2	3	1	2	2	2	15
Staff	2	2	1	2	2	2	2	2	15
Industry	5	2	1	3	4	1	4	2	22
Students	5	4	1	3	5	2	1	3	24
UK government	2	3	4	3	5	4	5	2	28
Local government	2	4	4	3	5	4	3	4	29
EU parliament	4	3	5	2	5	4	5	2	30

AUSTRALIA

	I1	I2	I3	I4	I5	I6	I7	I8	
University	4	4	2	2	3	3	2	3	23
AIB	3	2	4	1	2	3	1	2	18
Staff	2	1	2	2	1	1	2	2	13
Industry	2	2	1	1	2	2	1	2	13
Students	2	2	5	1	3	2	1	3	19
Aus government	5	5	5	4	2	5	3	4	33
State government	4	4	5	3	2	5	3	4	29

	I1	I2	I3	I4	I5	I6	I7	I8	
University	4	4	2	2	3	3	2	3	
Staff	2	1	2	2	1	1	2	3	23
Industry	2	2	1	1	2	2	2	2	13
AIB	3	2	4	1	2	3	1	2	13
Students	2	2	5	1	3	2	1	2	18
State government	4	4	5	3	2	5	1	3	19
							3	4	29
Aus government	5	5	5	4	2	5	3	4	33

Rank

	UK	Aus
University	1	5
AIB/CIOB	2	3
Staff	2	1
Industry	4	1
Students	5	4
Aus/UK government	6	7
State/Local government	7	6

Consistently highest- CIOB and staff

Rating

	UK	Aus
University	14	23
AIB/CIOB	15	18
Staff	15	13
Industry	22	13
Students	24	19
Aus/UK government	28	33
State/Local government	29	29

Case Study

u. Industry Questionnaire

Welcome

Greening the Construction Curriculum Questionnaire

This survey has been designed to enable the findings to be used to enhance curriculum design in the Built Environment programmes

Data Protection statement

All data collected in this survey will be held anonymously and securely. No personal data is asked for or retained.

Background Information: About you

1. Are you a member of a professional body?
(select all that apply)

- CIOB
- RICS
- ICE
- RIBA
- Other *(please specify)*:

What a grade?

2. Your age is between

20-30 30-40 40-50 50+

3. Are you a chartered environmentalist?

- Yes
- No
- Thinking of being

4. Please indicate your highest academic qualification?

- O level/CSE/GCSE
- A Level
- OND/ONC/NVQ/GNVQ
- HND/C or Foundation Degree
- BSc(Hons)/BSc --non CIOB accredited
- BSc(Hons)/BSc--CIOB accredited
- Masters/MPhil
- PhD
- Other

5. What type of work is the main function of your organisation?

- Design
- Facilities management
- Contracting-traditional
- Contracting- Design and Build
- Local Authority
- Education (HE or FE)
- Training
- Other

Recruitment, Training and Development In the Construction Industry

6. Does your company take on graduates?

- Yes- it is company policy to recruit this way
- Yes- sometimes
- No- we have a different recruitment policy

If yes, what % are from each disciplines
(select all that apply)

- Civil Engineering
- Construction Management
- Surveying
- Architecture
- Non-cognate

7. How would your employer ideally like to recruit the professionals of the future?

- Employ people at 16 and train completely in house
- Employ people at 18 and train completely in house
- Employ people at 16 and send on ONC and then HNC programmes on a day release basis
- Employ people at 18 and send on an HNC programmes on a day release basis
- Employ people/or continue employment of people with an HNC and send them on a part time degree programme
- Employ graduates of a cognate degree programme
- Employ graduates of a non-cognate degree programme and intensively train them in house
- Employ graduates of a non-cognate degree programme and send them on a conversion Masters programme
- Other *(please specify)*:

Attitude and Knowledge of the Environmental Impact of Construction

8. Has your attitude to environmental issues related to construction changed over the last 5 years?

- No, I wasn't concerned then and I am not now
- No, I was concerned then and I am still concerned now
- Yes, I wasn't concerned then but I am now
- Yes, I am more concerned now
- Yes, I am far more concerned now

9. Please indicate you agreement with the following statements

	SA	A	N	D	SD
a. The construction industry has not changed practices that will improve environmental behaviour because it doesn't know how to.	○	○	○	○	○
b. The construction industry has not changed practices that will improve environmental behaviour because the government has not brought in legislation to enforce this.	○	○	○	○	○
c. The construction industry has not changed practices that will improve environmental behaviour because it is driven solely for profit, and profit margins are to low to incentivise changing practices	○	○	○	○	○
d. The construction industry has changed practices that will improve environmental behaviour because the government has brought in legislation to enforce this	○	○	○	○	○
e. The construction industry has changed practices that will improve environmental behaviour because the government has brought in legislation to enforce this, but this is not enough	○	○	○	○	○
f. The construction industry has changed practices that will improve environmental behaviour because the government has brought in legislation to enforce this and also changing attitudes in the industry are promoting change on a company basis.	○	○	○	○	○
g. The construction industry has changed practices that will improve environmental behaviour because changing attitudes in the industry are promoting change on a company basis.	○	○	○	○	○

10. What do you understand by the term sustainable development?

11. What do you understand by the term green design?

12. What do you understand by the term sustainable construction?

The HE sector and Construction Education

13. Do you think that Universities are producing graduates who have enough knowledge about the environmental impact of construction work?

Yes- definitely   Yes- but not enough   No- they need more   No- definitely not   No opinion

14. Do you think that universities are producing graduates who have enough knowledge about how to reduce the effects of construction work on the environment?

Yes- definitely   Yes- but not enough   No- they need more   No- definitely not   No opinion

15. Do you think that universities are producing graduates who have the correct problem solving skills to develop innovative solutions to reducing environmental damage from construction work?

Yes- definitely   Yes- but not enough   No- they need more   No- definitely not   No opinion

16. Do you think that Universities are producing graduates who have good team working skills that enable problem solving to be facilitated as a team?

Yes- definitely   Yes- but not enough   No- they need more   No- definitely not   No opinion

17. How important do you the Higher Education sector is in providing the construction managers of the future?

Very Important   Important   Not important   Very unimportant

No opinion

18. How do you think HE construction curricula should be designed? What level of agreement you have with the following statements

	SA	A	N	SD	D
a. A set of learning outcomes for the whole programme should be defined and these should be broken down into smaller deliverable units that when put together achieve the programme expected learning outcomes.					
b. Units should be defined that can be delivered by staff, based on research interests and previous industry experience. These should be built up in order to develop the overall curriculum.					
c. Professional bodies should take the responsibility for curriculum design.					
d. A construction management degree is an educational programme with a vocational theme, training in specific areas should be left to industry once the student has graduated.					
e. Programmes should contain core subjects such as management, science and technology. Issues such as the environmental impact of construction should be integrated in these core subjects as opposed to teaching them as separate subjects.					
f. Programmes need themes that run through them and one of these themes should be sustainability.					

19. What level of importance do you place on the following subjects in the construction curriculum

	V.imp	Imp	Slightly imp	N. imp	V.N imp
a. Building Costs and Prices, Cashflow	┌	┌	┌	┌	┌
b. Programming and Planning of construction works	┌	┌	┌	┌	┌
c. Management Systems	┌	┌	┌	┌	┌
d. Health, Safety and Welfare in construction	┌	┌	┌	┌	┌
e. Environmental knowledge and ability to apply knowledge in given scenarios	┌	┌	┌	┌	┌
f. Ability to work with others	┌	┌	┌	┌	┌
g. Information Technology	┌	┌	┌	┌	┌
h. Communication skills	┌	┌	┌	┌	┌
i. Materials Technology	┌	┌	┌	┌	┌
j. Construction Law and Contracts	┌	┌	┌	┌	┌
k. Construction Technology	┌	┌	┌	┌	┌

20. What level of importance do you think there is in including sustainability in the following subjects?

	V.imp	Imp	Slightly imp	N. imp	V.N imp
a. Building Costs and Prices, Cashflow	┌	┌	┌	┌	┌
b. Programming and Planning of construction works	┌	┌	┌	┌	┌
c. Management Systems	┌	┌	┌	┌	┌
d. Health, Safety and Welfare in construction	┌	┌	┌	┌	┌
e. Ability to work with others	┌	┌	┌	┌	┌
f. Information Technology	┌	┌	┌	┌	┌

g. Communication skills					
h. Materials Technology					
i. Construction Law and Contracts					
j. Construction Technology					
k. All the above					

Curriculum Development

21. Do you think that research undertaken in Universities feeds into industry practices?

- Yes- a lot
- Yes- but not much
- Yes-I know of a couple of instances
- No- the industry is slow to adopt new practices and reticent to try new ideas developed via research
- No- most of the research undertaken in universities is to blue sky to be of benefit
- No- but industry does utilise research undertaken by outside bodies such as the BRE (Building Research Establishment)

22. How aware are you of what is included in the CIOB educational framework for undergraduate programmes?

V. aware   Aware   Neutral   N. aware   V. unaware

23. If you are aware, do you think that the framework is:

- Too rigid and doesn't allow for themes such as sustainability to be incorporated as much as is necessary.
- Very rigid, but this is a good thing as the graduates have the correct amount of skills and knowledge to progress directly to employment and perform well.
- Quite rigid, but does allow for each university to develop its own specialism within the curriculum
- Appropriate, all subjects are incorporated to the right amount at the right level.
- Very flexible and allows for staff research expertise to flourish in the curriculum.
- Not applicable as unaware

24. Do you think that there is enough involvement by industry in curriculum design of construction management HE programmes?

- Yes
- Maybe
- No
- Don't know

a. If yes go to Q25

If no or maybe, why?
b.

- Industry does not get asked to be involved
- Industry gets asked but doesn't generally want to participate because of time constraints
- Industrial requirements for degree programmes tend to focus on training aspects rather than education generally.
- Academic and industrial research is the main driver of curriculum design
- There is a trend now for Built Environment departments to employ lecturers with research backgrounds rather than industrial, and they have fewer industrial contacts.

25. Please indicate whether you think that construction management programmes focus on teaching sustainability issues?

- During the design phase
- During the construction phase
- During the design and construction phases
- For the post-construction phase
- All phases

26. How would you rank the use of real life case studies in educational projects?

- Very useful
- Useful
- Don't know
- Not useful

27. What do you think will change the attitudes of construction industry professionals towards promoting sustainable practices

- Changes to regulation and policy i.e. the building regulations
- Higher Education study

- Client demand for 'green' and sustainable buildings
- CPD delivered in house
- Further evidence of damage to the environment at a personal level

28. Do you think it is important for construction management students to study with students on other Built Environment programmes?

- Yes
- Maybe
- No

If yes, which programmes do you think it would be best for them to study with? Please tick as many as you think relevant
(select all that apply)

- Architects
- Civil Engineers
- Quantity Surveyors
- Building Surveyors
- Property Managers
- Planners
- Architectural Technologists

29. Comments are welcomed in relation to any omissions that you may consider to have been made in this survey.

Thank you for completing this survey.

Phase 3

v. Questionnaire 1

Joint Project Questionnaire 1

Welcome

As part of your assessment you are required to complete 3 questionnaires. This one must be completed and returned via the link by 9.00am on Monday 10th December 2008.

There are no right or wrong answers and this is NOT a multiple choice test, it is intended to gauge your perceptions. You will be awarded marks for completion, not on the accuracy of your answers. Please do not therefore spend time trying to work out the right answers to the questions, there aren't any!

Data Protection statement

All data collected in this survey will be held securely.

About you

1. Name:

2. What is your mode of study:

Full Time   Sandwich   Part Time

3. Which programme are you studying:

Construction Management or Building Design Technology and Management

Quantity Surveying

Building Surveying

Real Estate Management, Real Estate Management and Business or Property Management

4. Are you:

Male   Female

5. What is your age:

Under 25   25-29   30-39   40-49

6. Does your dissertation/final year project have any of the following words or phrases in its

title: Environment, Environmental, Sustainable, Sustainability, Green, Energy Efficiency.

Yes No

Awareness of Environmental Issues

7. How aware do you feel you are of environmental issues, specifically with regard to the Built Environment?

Very Aware Aware Slightly aware Unaware Very Unaware

8. Do you think your future employer will give you all the training you need with regard to improving environmental practices in the construction process?

Yes Maybe No

Your Attitude to Environmental Issues?

9. Has your attitude to the environment changed since you started your degree programme?

A very great deal A lot Moderately Slightly Not at all

10. Do you believe personally (regardless of any other opinion) that the issue of the environment is important?

A very great deal A lot Moderately Slightly Not at all

11. When buying your own house, would you pay more if it included more environmentally friendly products or systems?

Yes-Definitely Yes-Probably Maybe No-Probably not No-definitely not

12. Do you believe that technology alone can solve the environmental problems the world faces?

Yes-Definitely Yes-Probably Maybe No-Probably not No-definitely not

13. Do you think that the Construction Industry poses a major threat to the environment?

Yes-Definitely Yes-Probably Maybe No-Probably not No-definitely not

14. Do you believe that you will be able to make a difference to industry practices:

Now Upon graduation In five years time In ten tears time

15. Do you think the construction industry does enough to protect the environment?

Yes, a lot Yes, Maybe No- not enough No- definitely not enough
Don't know

16. How important do you consider it to be that whilst at University you develop an in depth knowledge of the impact of the construction industry and buildings on the environment?

Very Important Important Moderately important Not Important
Very Unimportant

17. How important do you think it is for construction professionals to inform the general public about the effects of construction work on the environment?

Very Important Important Moderately important Not Important
Very Unimportant

18. How important do you think it is for construction professionals to inform clients about the effects of construction work on the environment?

Very Important Important Moderately important Not Important
Very Unimportant

19. How important do you rank the following factors in relation to the construction of a building? Use 1-6 with 1 being the most important

	1	2	3	4	5	6
a. Low Cost						
b. Short Contract Duration						
c. Aesthetically pleasing						
d. Good Quality of Work						
e. Good Health and Safety Record						
f. Environmentally Friendly						

20. Other important factors in relation to the construction of a building (please specify)

Your Knowledge of Environmental Issues

21. How would you rank the following materials or systems environmentally?

	Very Damaging	Damaging	Average Good	Very Good
a. uPVC pipes				
b. Photovoltaic cells				
c. Concrete				
d. Clay drain pipes				
e. Refurbishment				

22. How would you rank the following regarding the long term viability of the leasing potential/resale potential of a residential multi storey building?

	Very Good	Good	Average	Not that good	Don't know
a. Low carbon footprint					
b. Zero net carbon emissions					
c. Ease of refurbishment					
d. BREEAM qualification					
e. Reduced energy use					
f. Low cost					
g. Aesthetically pleasing					
h. Eco homes rating					

23. Rank the following procurement methods as to how effective they are for encouraging the use of sustainable construction techniques

	Very Good	Good	Average	Not that good	Don't know
a. Design and Build					
b. Construction Management(contractor acts as a consultant)					
c. Private Finance Initiative (PFI)					

d. Traditional (open or selective tendering)					
e. Partnering					
f. Whole life value approaches					

24. How important do you think the Construction Industry generally believes the following factors are in relation to the construction of a building? Use 1-6 with 1 being the most important

	1	2	3	4	5	6
a. Low Cost						
b. Short Contract Duration						
c. Aesthetically pleasing						
d. Good Quality of Work						
e. Good Health and Safety Record						
f. Environmentally Friendly						

25. Other important factors (please specify)

Your Learning Style

26. Rank the following group based scenarios 1-4 as to how effective they are as learning tools for you(1= the highest)

	1	2	3	4
a. Small group, single disciplinary projects				
b. Small group, interdisciplinary projects				
c. Large group, single disciplinary projects				
d. Large group, interdisciplinary projects				

27. Rank the following 1-6 regarding your preferred teaching and learning approach? (1= the highest)

	1	2	3	4	5	6
a. Lectures and tutorials with set tasks						
b. Lectures and tutorials that allow for working on assignments						

c. Lectures only						
d. Group based activities						
e. Individual work with a strong research requirement						
f. Working with real life case studies						

28. Do you think that sustainability as a subject should be taught:
Rank 1-5 with 1 being your preferred option

	1	2	3	4	5
a. Applied in the main subjects you study(integrated)					
b. As a separate subject (fragmented)					
c. As a combination of integration and fragmentation					
d. Mainly through application in projects					
e. As a combination integration and fragmentation and application in projects.					

29. Has the process of personal development planning helped to improve your skills and knowledge:

Yes- a lot   Yes- but not much   Moderately   No- not much   No-not at all

30. What do you think will be the best type of information to assist you in undertaking the Joint Project? Rank these 1-6 with 1 being the most useful

	1	2	3	4	5	6
a. Web sites						
b. Journal articles						
c. Books						
d. Learning from other people						
e. Previously undertaken coursework						
f. Work currently being undertaken for you IIR/Dissertation.						

31. What do you think that you personally will be able to do to help protect the environment from the effects of buildings and construction work in your career.

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE

w. Questionnaire 2

Joint Project Questionnaire 2

Welcome

As part of your assessment you are required to complete 3 questionnaires. This one must be completed and returned via the link by 9.00am on Thursday 13th December 2008.

There are no right or wrong answers and this is NOT a multiple choice test, it is intended to gauge your perceptions. You will be awarded marks for completion, not on the accuracy of your answers. Please do not therefore spend time trying to work out the right answers to the questions, there aren't any!

Data Protection statement

All data collected in this survey will be held securely.

About you

1. Name:

2. What is your mode of study:

- Full Time
- Sandwich
- Part Time

3. Which programme are you studying:

- Construction Management or Building Design Technology and Management
- Quantity Surveying
- Building Surveying
- Real Estate Management, Real Estate Management and Business or Property Management

4. Are you:

- Male
- Female

5. What is your age:

- Under 25
- 25-29
- 30-39
- 40-49

6. Does your dissertation/final year project have any of the following words or phrases in its title: Environment, Environmental, Sustainable, Sustainability, Green, Energy Efficiency.

Yes No

Awareness of Environmental Issues

7. How aware do you feel you are of environmental issues, specifically with regard to the Built Environment?

Very Aware Aware Slightly aware Unaware Very Unaware

8. Do you think your future employer will give you all the training you need with regard to improving environmental practices in the construction process?

Yes Maybe No

Your Attitude to Environmental Issues?

9. Has your attitude to the environment changed since you started this project?

A very great deal A lot Moderately Slightly Not at all

10. Do you believe personally (regardless of any other opinion) that the issue of the environment is important?

A very great deal A lot Moderately Slightly Not at all

11. When buying your own house, would you pay more if it included more environmentally friendly products or systems?

Yes-Definitely Yes-Probably Maybe No-Probably not No-definitely not

12. Do you believe that technology alone can solve the environmental problems the world faces?

Yes-Definitely Yes-Probably Maybe No-Probably not No-definitely not

13. Do you think that the Construction Industry poses a major threat to the environment?

Yes-Definitely Yes-Probably Maybe No-Probably not No-definitely not

14. Do you believe that you will be able to make a difference to industry practices:

Now Upon graduation In five years time In ten tears time

15. Do you think the construction industry does enough to protect the environment?

Yes, a lot Yes, Maybe No- not enough No- definitely not enough

Don't know

16. How important do you consider it to be that whilst at University you develop an in depth knowledge of the impact of the construction industry and buildings on the environment?

Very Important   Important   Moderately important   Not Important
Very Unimportant

17. How important do you think it is for construction professionals to inform the general public about the effects of construction work on the environment?

Very Important   Important   Moderately important   Not Important
Very Unimportant

18. How important do you think it is for construction professionals to inform clients about the effects of construction work on the environment?

Very Important   Important   Moderately important   Not Important
Very Unimportant

19. How important do you rank the following factors in relation to the construction of a building? Use 1-6 with 1 being the most important

	1	2	3	4	5	6
a. Low Cost						
b. Short Contract Duration						
c. Aesthetically pleasing						
d. Good Quality of Work						
e. Good Health and Safety Record						
f. Environmentally Friendly						

20. Other important factors in relation to the construction of a building (please specify)

Your Knowledge of Environmental Issues

21. How would you rank the following materials or systems environmentally?

	Very Damaging	Damaging	Average Good	Very Good
a. uPVC pipes	○	○	○	○
b. Photovoltaic cells	○	○	○	○
c. Concrete	○	○	○	○
d. Clay drain pipes	○	○	○	○
e. Refurbishment	○	○	○	○

22. How would you rank the following regarding the long term viability of the leasing potential/resale potential of a residential multi storey building?

	Very Good	Good	Average	Not that good	Don't know
a. Low carbon footprint	○	○	○	○	○
b. Zero net carbon emissions	○	○	○	○	○
c. Ease of refurbishment	○	○	○	○	○
d. BREEAM qualification	○	○	○	○	○
e. Reduced energy use	○	○	○	○	○
f. Low cost	○	○	○	○	○
g. Aesthetically pleasing	○	○	○	○	○
h. Eco homes rating	○	○	○	○	○

23. Rank the following procurement methods as to how effective they are for encouraging the use of sustainable construction techniques

	Very Good	Good	Average	Not that good	Don't know
a. Design and Build	○	○	○	○	○
b. Construction Management(contractor acts as a consultant)	○	○	○	○	○
c. Private Finance Initiative (PFI)	○	○	○	○	○

d. Traditional (open or selective tendering)					
e. Partnering					
f. Whole life value approaches					

24. How important do you think the Construction Industry generally believes the following factors are in relation to the construction of a building? Use 1-6 with 1 being the most important

	1	2	3	4	5	6
a. Low Cost						
b. Short Contract Duration						
c. Aesthetically pleasing						
d. Good Quality of Work						
e. Good Health and Safety Record						
f. Environmentally Friendly						

25. Other important factors (please specify)

Your Learning Style

26. Rank the following group based scenarios 1-4 as to how effective they are as learning tools for you(1= the highest)

	1	2	3	4
a. Small group, single disciplinary projects				
b. Small group, interdisciplinary projects				
c. Large group, single disciplinary projects				
d. Large group, interdisciplinary projects				

27. Rank the following 1-6 regarding your preferred teaching and learning approach? (1= the highest)

	1	2	3	4	5	6
a. Lectures and tutorials with set tasks						
b. Lectures and tutorials that allow for working on assignments						

c. Lectures only						
d. Group based activities						
e. Individual work with a strong research requirement						
f. Working with real life case studies						

28. Do you think that sustainability as a subject should be taught:
Rank 1-5 with 1 being your preferred option

	1	2	3	4	5
a. Applied in the main subjects you study(integrated)					
b. As a separate subject (fragmented)					
c. As a combination of integration and fragmentation					
d. Mainly through application in projects					
e. As a combination integration and fragmentation and application in projects.					

29. Has the process of personal development planning helped to improve your skills and knowledge:

Yes- a lot   Yes- but not much   Moderately   No- not much   No-not at all

30. What do you think will be the best type of information to assist you in undertaking the Joint Project? Rank these 1-6 with 1 being the most useful

	1	2	3	4	5	6
a. Web sites						
b. Journal articles						
c. Books						
d. Learning from other people						
e. Previously undertaken coursework						
f. Work currently being undertaken for you IIR/Dissertation.						

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE

x. Questionnaire 3

Joint Project Questionnaire 3

Welcome

As part of your assessment you are required to complete 3 questionnaires. This one must be completed and returned via the link by 9.00am on Monday 17th December 2008.

There are no right or wrong answers and this is NOT a multiple choice test, it is intended to gauge your perceptions. You will be awarded marks for completion, not on the accuracy of your answers. Please do not therefore spend time trying to work out the right answers to the questions, there aren't any!

Data Protection statement

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About you

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- Sandwich
- Part Time

3. Which programme are you studying:

- Construction Management or Building Design Technology and Management
- Quantity Surveying
- Building Surveying
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4. Are you:

- Male
- Female

5. What is your age:

- Under 25
- 25-29
- 30-39
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Very Aware Aware Slightly aware Unaware Very Unaware

8. Do you think your future employer will give you all the training you need with regard to improving environmental practices in the construction process?

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Your Attitude to Environmental Issues?

9. Has your attitude to the environment changed whilst undertaking the joint project?

A very great deal A lot Moderately Slightly Not at all

10. Do you believe personally (regardless of any other opinion) that the issue of the environment is important?

A very great deal A lot Moderately Slightly Not at all

11. When buying your own house, would you pay more if it included more environmentally friendly products or systems?

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14. Do you believe that you will be able to make a difference to industry practices:

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16. How important do you consider it to be that whilst at University you develop an in depth knowledge of the impact of the construction industry and buildings on the environment?

Very Important Important Moderately important Not Important Very Unimportant

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18. How important do you think it is for construction professionals to inform clients about the effects of construction work on the environment?

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19. How important do you rank the following factors in relation to the construction of a building? Use 1-6 with 1 being the most important

	1	2	3	4	5	6
a. Low Cost						
b. Short Contract Duration						
c. Aesthetically pleasing						
d. Good Quality of Work						
e. Good Health and Safety Record						
f. Environmentally Friendly						

20. Other important factors in relation to the construction of a building (please specify)

Your Knowledge of Environmental Issues

21. How would you rank the following materials or systems environmentally?

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b. Photovoltaic cells				
c. Concrete				
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e. Refurbishment				

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	Very Good	Good	Average	Not that good	Don't know
a. Low carbon footprint					
b. Zero net carbon emissions					
c. Ease of refurbishment					
d. BREEAM qualification					
e. Reduced energy use					
f. Low cost					
g. Aesthetically pleasing					
h. Eco homes rating					

23. Rank the following procurement methods as to how effective they are for encouraging the use of sustainable construction techniques

	Very Good	Good	Average	Not that good	Don't know
a. Design and Build					
b. Construction Management(contractor acts as a consultant)					
c. Private Finance Initiative (PFI)					
d. Traditional (open or selective tendering)					
e. Partnering					
f. Whole life value approaches					

24. How important do you think the Construction Industry generally believes the following factors are in relation to the construction of a building? Use 1-6 with 1 being the most important

	1	2	3	4	5	6
a. Low Cost						
b. Short Contract Duration						
c. Aesthetically pleasing						
d. Good Quality of Work						
e. Good Health and Safety Record						
f. Environmentally Friendly						

25. Other important factors (please specify)

Your Learning Style

26. Rank the following group based scenarios 1-4 as to how effective they are as learning tools for you(1= the highest)

	1	2	3	4
a. Small group, single disciplinary projects				
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c. Large group, single disciplinary projects				
d. Large group, interdisciplinary projects				

27. Rank the following 1-6 regarding your preferred teaching and learning approach? (1= the highest)

	1	2	3	4	5	6
a. Lectures and tutorials with set tasks						
b. Lectures and tutorials that allow for working on assignments						
c. Lectures only						

d. Group based activities	○	○	○	○	○	○
e. Individual work with a strong research requirement	○	○	○	○	○	○
f. Working with real life case studies	○	○	○	○	○	○

28. Do you think that sustainability as a subject should be taught:
Rank 1-5 with 1 being your preferred option

	1	2	3	4	5
a. Applied in the main subjects you study(integrated)	○	○	○	○	○
b. As a separate subject (fragmented)	○	○	○	○	○
c. As a combination of integration and fragmentation	○	○	○	○	○
d. Mainly through application in projects	○	○	○	○	○
e. As a combination integration and fragmentation and application in projects.	○	○	○	○	○

29. Has the process of personal development planning helped to improve your skills and knowledge:

○ Yes- a lot ○ Yes- but not much ○ Moderately ○ No- not much ○ No-not at all

30. What do you think will be the best type of information to assist you in undertaking the Joint Project? Rank these 1-6 with 1 being the most useful

	1	2	3	4	5	6
a. Web sites	○	○	○	○	○	○
b. Journal articles	○	○	○	○	○	○
c. Books	○	○	○	○	○	○
d. Learning from other people	○	○	○	○	○	○
e. Previously undertaken coursework	○	○	○	○	○	○
f. Work currently being undertaken for you IIR/Dissertation.	○	○	○	○	○	○

Reflections

31. Please reflect briefly on the processes undertaken in the Joint Project.

32. Do you think that the project has increased your knowledge of sustainable construction, design and property management?

- Yes- sustainable construction
- Yes -- sustainable design
- Yes- sustainable property management
- Yes- sustainable construction and design
- Yes- sustainable construction and property management
- Yes- sustainable design and property management
- Yes- all three
- No

a. If Yes, how much improvement has occurred:
A great deal Quite a lot Moderately A small amount Only really reinforcing what I really knew

b. If No, please go to Q33.

33. What facilitated this change? Please rank the following 1-6 with 1 being the most useful.

	1	2	3	4	5	6
a. The video on day 1						
b. Undertaking research for the project						
c. From peers within the same discipline						
d. From peers from other disciplines						
e. Application of principles in a project						
f. The 'real lifeness' of the project						
g. Written materials						

34. How do you think that the School could have improved its teaching and learning opportunities to have improved your knowledge of environmental issues before your started the Joint Project?

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE

y. Interpretation of SPSS output data for Chi square tests

Programme of Study * Level of awareness of environmental issues Crosstabulation

			Level of awareness of environmental issues			Total
			Very aware	Aware	Slightly aware	
Programme of Study	Construction Management	Count	9	25	5	39
		Expected Count	5.7	22.4	10.9	39.0
	Quantity Surveying	Count	5	50	22	77
		Expected Count	11.2	44.3	21.5	77.0
	Building Surveying	Count	8	17	8	33
		Expected Count	4.8	19.0	9.2	33.0
	Real Estate Management	Count	5	15	17	37
		Expected Count	5.4	21.3	10.3	37.0
Total		Count	27	107	52	186
		Expected Count	27.0	107.0	52.0	186.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	18.302[a]	6	.006
Likelihood Ratio	18.834	6	.004
Linear-by-Linear Association	4.458	1	.035
N of Valid Cases	186		

a. 1 cells (8.3%) have expected count less than 5. The minimum expected count is 4.79.

A low significance value (typically below 0.05) indicates that there may be some relationship between the two variables.

No more than 20% can have expected counts of less than 5

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.314			.006
	Cramer's V	.222			.006
Ordinal by Ordinal	Gamma	.218	.103	2.099	.036
N of Valid Cases		186			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

the low significance values for both cramer's v and gamma indicate that there is a relationship between the two variables...

but the low values for both test statistics indicate that the relationship between the two variables is a weak one.

z. Interpretation of SPSS output data for Kolmogorov-Smirnov tests

One-Sample Kolmogorov-Smirnov Test

		Level of awareness of environmental issues	Level of awareness of environmental issues
N		186	184
Normal Parameters[a,b]	Mean	2.13	2.01
	Std. Deviation	.639	.627
Most Extreme Differences	Absolute	.304	.306
	Positive	.304	.306
	Negative	-.272	-.303
Kolmogorov-Smirnov Z		4.142	4.148
Asymp. Sig. (2-tailed)		.000	.000

a. Test distribution is Normal.

b. Calculated from data.

Parameters of the theoretical distribution are estimated from the observed data.

Absolute indicates the largest difference between the theoretical cumulative distribution and the observed cumulative distribution function

Large significance values (>.05) indicate that the observed distribution corresponds to the theoretical distribution.
In this example for both sets of data the significance values are less than .05 and therefore the data is non-parametric

aa. Interpretation of SPSS output data for Wilcoxon signed rank tests

Ranks

		N	Mean Rank	Sum of Ranks
Level of awareness of environmental issues - Level of awareness of environmental issues	Negative Ranks	45[a]	33.72	1517.50
	Positive Ranks	22[b]	34.57	760.50
	Ties	116[c]		
	Total	183		

a. Level of awareness of environmental issues < Level of awareness of environmental issues

b. Level of awareness of environmental issues > Level of awareness of environmental issues

c. Level of awareness of environmental issues = Level of awareness of environmental issues

The absolute differences between the variables are ranked and the ranks are split into three groups Negative ranks contains those cases for which the value of the second variable exceeds the value of the first variable. Positive ranks are vice Versa and ties are when the two variables are the same

If the two variables do not differ, the sum of the positive ranks will approximately equal the sum of the negative ranks. The sum of the ranks for the less frequent sign is the statistic used in the Wilcoxon test.

Test Statistics[b]

	Level of awareness of environmental issues - Level of awareness of environmental issues
Z	-2.591[a]
Asymp. Sig. (2-tailed)	.010

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

The sum of the ranks for the less frequent sign is standardized.

Small significance values (<.05) indicate that the two variables differ in distribution and that there is a significant difference Between the two samples

ab. Example of SPSS output data

Question: How aware do you feel you are of environmental issues, specifically with regard to the Built Environment?

Questionnaire 1-responses by programme and mode

Programme of Study * Level of awareness of environmental issues Crosstabulation

Count

		Level of awareness of environmental issues			Total
		Very aware	Aware	Slightly aware	
Programme of Study	Construction Management	9	25	5	39
	Quantity Surveying	5	50	22	77
	Building Surveying	7	17	9	33
	Real Estate Management	4	16	17	37
Total		25	108	53	186

Mode of Study * Level of awareness of environmental issues Crosstabulation

Count

		Level of awareness of environmental issues			Total
		Very aware	Aware	Slightly aware	
Mode of Study	Full time	19	65	35	119
	Part time	4	16	5	25
	Sandwich	2	26	12	40
Total		25	107	52	184

Questionnaire 2-responses by programme and mode

Programme of Study * Level of awareness of environmental issues Crosstabulation

Count

		Level of awareness of environmental issues					Total
		Very aware	Aware	Slightly aware	Unaware	Very unaware	
Programme of Study	Construction Management	15	22	1	0	0	38
	Quantity Surveying	10	45	19	2	1	77
	Building Surveying	8	21	2	0	0	31
	Real Estate Managem	2	26	8	0	0	36
Total		35	114	30	2	1	182

Mode of Study * Level of awareness of environmental issues Crosstabulation

Count

		Level of awareness of environmental issues					
		Very aware	Aware	Slightly aware	Unaware	Very unaware	Total
Mode of Study	Full time	23	77	15	1	0	116
	Part time	5	15	5	0	0	25
	Sandwich	7	20	11	1	1	40
Total		35	112	31	2	1	181

Questionnaire 3-responses by programme and mode

Programme of Study * Awareness of Env.Issues Crosstabulation

Count

		Awareness of Env.Issues			
		Very aware	Aware	Slightly aware	Total
Programme of Study	CM	20	18	2	40
	QS	19	48	10	77
	BS	11	22	2	35
	REM	7	23	5	35
Total		57	111	19	187

Mode of Study * Awareness of Env.Issues Crosstabulation

Count

		Awareness of Env.Issues			
		Very aware	Aware	Slightly aware	Total
Mode of Study	Full time	43	68	10	121
	Sandwich	4	16	4	24
	Part time	9	26	5	40
Total		56	110	19	185

Questionnaires 1 and 2 -Mean, Median, Mode and Sum

Statistics

		Level of awareness of environmental issues	Level of awareness of environmental issues
N	Valid	186	183
	Missing	2	5
Mean		2.15	2.02
Median		2.00	2.00
Mode		2	2
Std. Deviation		.632	.675
Variance		.399	.456
Sum		400	369

Questionnaire 3 -Mean, Median, Mode and Sum

Statistics

Awareness of Env.Issues

N	Valid	187
	Missing	6
Mean		1.80
Median		2.00
Mode		2
Std. Deviation		.606
Sum		336

Questionnaire 1 –Frequency and Percentages

Level of awareness of environmental issues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very aware	25	13.3	13.4	13.4
	Aware	108	57.4	58.1	71.5
	Slightly aware	53	28.2	28.5	100.0
	Total	186	98.9	100.0	
Missing	System	2	1.1		
Total		188	100.0		

Questionnaire 2 –Frequency and Percentages

Level of awareness of environmental issues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very aware	35	18.6	19.1	19.1
	Aware	114	60.6	62.3	81.4
	Slightly aware	31	16.5	16.9	98.4
	Unaware	2	1.1	1.1	99.5
	Very unaware	1	.5	.5	100.0
	Total	183	97.3	100.0	
Missing	System	5	2.7		
Total		188	100.0		

Questionnaire 3 –Frequency and Percentages

Awareness of Env.Issues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very aware	57	29.5	30.5	30.5
	Aware	111	57.5	59.4	89.8
	Slightly aware	19	9.8	10.2	100.0
	Total	187	96.9	100.0	
Missing	System	6	3.1		
Total		193	100.0		

Questionnaires 1, 2 and 3- by level of previous environmental interest

Prior Environmental Interest * Level of awareness of environmental issues

Count

		Level of awareness of environmental issues			Total
		Very aware	Aware	Slightly aware	
Prior Environmental Interest	Yes	12	29	9	50
	No	13	79	43	135
Total		25	108	52	185

Prior Environmental Interest * Level of awareness of environmental issues Crosstabulation

Count

		Level of awareness of environmental issues					Total
		Very aware	Aware	Slightly aware	Unaware	Very unaware	
Prior Environmental Interest	Yes	15	31	4	0	0	50
	No	20	82	27	2	1	132
Total		35	113	31	2	1	182

Prior Environmental Interest * Awareness of Env.Issues Crosstabulation

Count

		Awareness of Env.Issues			Total
		Very aware	Aware	Slightly aware	
Prior Environmental Interest	Yes	21	33	1	55
	No	36	76	18	130
Total		57	109	19	185

Chi Square tests

The slightly aware, unaware and very unaware categories needed to be combined and the age distribution to just two categories, over and under 25, to ensure validity of the tests. The very low number of female students has meant that it is not possible to statistically test the data to show differences in response by gender.

Questionnaire 1- by mode

Mode of Study * Level of awareness of environmental issues

			Level of awareness of environmental issues			Total
			Very aware	Aware	Slightly aware	
Mode of Study	Full time	Count	19	65	35	119
		Expected Count	16.2	69.2	33.6	119.0
	Part time	Count	4	16	5	25
		Expected Count	3.4	14.5	7.1	25.0
	Sandwich	Count	2	26	12	40
		Expected Count	5.4	23.3	11.3	40.0
Total		Count	25	107	52	184
		Expected Count	25.0	107.0	52.0	184.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.201(a)	4	.380
Likelihood Ratio	4.925	4	.295
Linear-by-Linear Association	.626	1	.429
N of Valid Cases	184		

a 1 cells (11.1%) have expected count less than 5. The minimum expected count is 3.40.

Questionnaire 1- by programme

			Level of awareness of environmental issues			Total
			Very aware	Aware	Slightly aware	
Programme of Study	Construction Management	Count	9	25	5	39
		Expected Count	5.2	22.6	11.1	39.0
	Quantity Surveying	Count	5	50	22	77
		Expected Count	10.3	44.7	21.9	77.0
	Building Surveying	Count	7	17	9	33
		Expected Count	4.4	19.2	9.4	33.0
	Real Estate Management	Count	4	16	17	37
		Expected Count	5.0	21.5	10.5	37.0
Total		Count	25	108	53	186
		Expected Count	25.0	108.0	53.0	186.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.981(a)	6	.009
Likelihood Ratio	17.317	6	.008
Linear-by-Linear Association	6.086	1	.014
N of Valid Cases	186		

a 2 cells (16.7%) have expected count less than 5. The minimum expected count is 4.44.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.314			.006
	Cramer's V	.222			.006
Ordinal by Ordinal	Gamma	.218	.103	2.099	.036
N of Valid Cases		186			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

There is a statistically significant difference but there is a weak relationship.

Questionnaire 1- by age

Age Profile * Level of awareness of environmental issues Crosstabulation

			Level of awareness of environmental issues			Total
			Very aware	Aware	Slightly aware	
Age Profile	Under 25	Count	17	78	39	134
		Expected Count	19.5	77.1	37.5	134.0
	Over 25	Count	10	29	13	52
		Expected Count	7.5	29.9	14.5	52.0
Total		Count	27	107	52	186
		Expected Count	27.0	107.0	52.0	186.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.370[a]	2	.504
Likelihood Ratio	1.315	2	.518
Linear-by-Linear Association	1.039	1	.308
N of Valid Cases	186		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.55.

Questionnaire 1- by level of prior environmental interest

Prior Environmental Interest * Level of awareness of environmental issues Crosstabulation

			Level of awareness of environmental issues			Total
			Very aware	Aware	Slightly aware	
Prior Environmental Interest	Yes	Count	13	29	8	50
		Expected Count	7.3	28.9	13.8	50.0
	No	Count	14	78	43	135
		Expected Count	19.7	78.1	37.2	135.0
Total		Count	27	107	51	185
		Expected Count	27.0	107.0	51.0	185.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.433[a]	2	.009
Likelihood Ratio	9.165	2	.010
Linear-by-Linear Association	8.885	1	.003
N of Valid Cases	185		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.30.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.226			.009
	Cramer's V	.226			.009
Ordinal by Ordinal	Gamma	.424	.130	2.973	.003
N of Valid Cases		185			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Moderate relationship in ordinal data

Questionnaire 2- by mode

Mode of Study * Level of awareness of environmental issues Crosstabulation

			Level of awareness of environmental issues			Total
			Very aware	Aware	Slightly aware	
Mode of Study	Full time	Count	23	77	17	117
		Expected Count	22.5	70.7	23.8	117.0
	Part time	Count	5	15	5	25
		Expected Count	4.8	15.1	5.1	25.0
	Sandwich	Count	7	18	15	40
		Expected Count	7.7	24.2	8.1	40.0
Total		Count	35	110	37	182
		Expected Count	35.0	110.0	37.0	182.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.956(a)	4	.041
Likelihood Ratio	9.144	4	.058
Linear-by-Linear Association	4.455	1	.035
N of Valid Cases	182		

a 1 cells (11.1%) have expected count less than 5. The minimum expected count is 4.81.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.196			.030
	Cramer's V	.196			.030
Ordinal by Ordinal	Gamma	.241	.137	1.722	.085
N of Valid Cases		182			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Weak association

Questionnaire 2- by programme

Programme of Study * Level of awareness of environmental issues Crosstabulation

			Level of awareness of environmental issues			Total
			Very aware	Aware	Slightly aware	
Programme of Study	Construction Management	Count	15	21	2	38
		Expected Count	7.3	23.3	7.5	38.0
	Quantity Surveying	Count	10	44	23	77
		Expected Count	14.7	47.1	15.1	77.0
	Building Surveying	Count	8	21	2	31
		Expected Count	5.9	19.0	6.1	31.0
	Real Estate Management	Count	2	26	9	37
		Expected Count	7.1	22.6	7.3	37.0
Total		Count	35	112	36	183
		Expected Count	35.0	112.0	36.0	183.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	26.491(a)	6	.000
Likelihood Ratio	28.157	6	.000
Linear-by-Linear Association	5.671	1	.017
N of Valid Cases	183		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.93.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.380			.000
	Cramer's V	.269			.000
Ordinal by Ordinal	Gamma	.247	.095	2.508	.012
N of Valid Cases		183			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Weak association

Questionnaire 2- by age

Age Profile * Level of awareness of environmental issues Crosstabulation

			Level of awareness of environmental issues			
			Very aware	Aware	Slightly aware	Total
Age Profile	Under 25	Count	24	85	23	132
		Expected Count	25.1	80.3	26.5	132.0
	Over 25	Count	11	27	14	52
		Expected Count	9.9	31.7	10.5	52.0
Total		Count	35	112	37	184
		Expected Count	35.0	112.0	37.0	184.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.800(a)	2	.247
Likelihood Ratio	2.734	2	.255
Linear-by-Linear Association	.404	1	.525
N of Valid Cases	184		

a 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.89.

Questionnaire 2- by level of prior environmental interest

Prior Environmental Interest * Level of awareness of environmental issues Crosstabulation

			Level of awareness of environmental issues			
			Very aware	Aware	Slightly aware	Total
Prior Environmental Interest	Yes	Count	15	31	4	50
		Expected Count	9.6	30.3	10.1	50.0
	No	Count	20	80	33	133
		Expected Count	25.4	80.7	26.9	133.0
Total		Count	35	111	37	183
		Expected Count	35.0	111.0	37.0	183.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.354[a]	2	.009
Likelihood Ratio	10.001	2	.007
Linear-by-Linear Association	9.277	1	.002
N of Valid Cases	183		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 9.56.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.226			.009
	Cramer's V	.226			.009
Ordinal by Ordinal	Gamma	.454	.125	3.222	.001
N of Valid Cases		183			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Questionnaire 3- by mode, unfeasible test due to lack of unawareness by this stage
Questionnaire 3- by programme, unfeasible test due to lack of unawareness by this stage

Questionnaire 3- by age

Age * Awareness of Env.Issues Crosstabulation

			Awareness of Env.Issues			Total
			Very aware	Aware	Slightly aware	
Age	under 25	Count	42	79	12	133
		Expected Count	40.8	78.7	13.6	133.0
	over 25	Count	15	31	7	53
		Expected Count	16.2	31.3	5.4	53.0
Total		Count	57	110	19	186
		Expected Count	57.0	110.0	19.0	186.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.788[a]	2	.674
Likelihood Ratio	.758	2	.685
Linear-by-Linear Association	.572	1	.449
N of Valid Cases	186		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.41.

Questionnaire 3- by level of prior environmental interest

Prior Environmental Interest * Awareness of Env.Issues Crosstabulation

			Awareness of Env.Issues			
			Very aware	Aware	Slightly aware	Total
Prior Environmental Interest	Yes	Count	21	33	1	55
		Expected Count	16.9	32.4	5.6	55.0
	No	Count	36	76	18	130
		Expected Count	40.1	76.6	13.4	130.0
Total		Count	57	109	19	185
		Expected Count	57.0	109.0	19.0	185.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.840[a]	2	.033
Likelihood Ratio	8.633	2	.013
Linear-by-Linear Association	5.287	1	.021
N of Valid Cases	185		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.65.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	.192			.033
	Cramer's V	.192			.033
Ordinal by Ordinal	Gamma	.328	.131	2.321	.020
N of Valid Cases		185			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

One sample Kolmogorov-Smirnov test Q1-Q2

One-Sample Kolmogorov-Smirnov Test

		Q7	Q7
N		199	183
Normal Parameters[a,b]	Mean	2.15	2.02
	Std. Deviation	.680	.675
Most Extreme Differences	Absolute	.321	.324
	Positive	.321	.324
	Negative	-.277	-.299
Kolmogorov-Smirnov Z		4.534	4.382
Asymp. Sig. (2-tailed)		.000	.000

a. Test distribution is Normal.

b. Calculated from data.

NULL HYPOTHESIS REJECTED THEREFORE NON PARAMETRIC TEST REQUIRED

One sample Kolmogorov Smirnov Test Q2-Q3

One-Sample Kolmogorov-Smirnov Test

		Q7	Q7
N		183	178
Normal Parameters[a,b]	Mean	2.02	1.88
	Std. Deviation	.675	.585
Most Extreme Differences	Absolute	.324	.344
	Positive	.324	.302
	Negative	-.299	-.344
Kolmogorov-Smirnov Z		4.382	4.589
Asymp. Sig. (2-tailed)		.000	.000

a. Test distribution is Normal.

b. Calculated from data.

NULL HYPOTHESIS REJECTED THEREFORE NON PARAMETRIC TEST REQUIRED

One sample Kolmogorov Smirnov Test Q1-Q3

One-Sample Kolmogorov-Smirnov Test

		Q7	Q7
N		199	178
Normal Parameters[a,b]	Mean	2.15	1.88
	Std. Deviation	.680	.585
Most Extreme Differences	Absolute	.321	.344
	Positive	.321	.302
	Negative	-.277	-.344
Kolmogorov-Smirnov Z		4.534	4.589
Asymp. Sig. (2-tailed)		.000	.000

a. Test distribution is Normal.

b. Calculated from data.

In all three cases the Null hypothesis is rejected and the data distribution is not normal, and therefore a non parametric test is used.

Wilcoxon Signed Ranks Test- Q1-Q2

Ranks

		N	Mean Rank	Sum of Ranks
Level of awareness of environmental issues - Level of awareness of environmental issues	Negative Ranks	46(a)	34.14	1570.50
	Positive Ranks	21(b)	33.69	707.50
	Ties	115(c)		
	Total	182		

a Level of awareness of environmental issues < Level of awareness of environmental issues
b Level of awareness of environmental issues > Level of awareness of environmental issues
c Level of awareness of environmental issues = Level of awareness of environmental issues

Test Statistics(b)

	Level of awareness of environmental issues - Level of awareness of environmental issues
Z	-2.969(a)
Asymp. Sig. (2-tailed)	.003

a Based on positive ranks.
b Wilcoxon Signed Ranks Test

REJECT THE NULL HYPOTHESIS

Wilcoxon Signed Ranks Test- Q2-Q3

Ranks

		N	Mean Rank	Sum of Ranks
Q7 - Q7	Negative Ranks	52[a]	42.08	2188.00
	Positive Ranks	32[b]	43.19	1382.00
	Ties	88[c]		
	Total	172		

a. Q7 < Q7

b. Q7 > Q7

c. Q7 = Q7

Test Statistics[b]

	Q7 - Q7
Z	-1.979[a]
Asymp. Sig. (2-tailed)	.048

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

Reject the null hypothesis

Wilcoxon Signed Ranks Test- Q1-Q3

Ranks

		N	Mean Rank	Sum of Ranks
Q7 - Q7	Negative Ranks	63[a]	44.35	2794.00
	Positive Ranks	24[b]	43.08	1034.00
	Ties	87[c]		
	Total	174		

a. Q7 < Q7

b. Q7 > Q7

c. Q7 = Q7

Test Statistics[b]

	Q7 - Q7
Z	-4.004[a]
Asymp. Sig. (2-tailed)	.000

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

Reject the null hypothesis

Results for Construction Management only, Q1, Q2, Q3

Level of awareness of environmental issues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very aware	9	23.1	23.1	23.1
	Aware	25	64.1	64.1	87.2
	Slightly aware	5	12.8	12.8	100.0
	Total	39	100.0	100.0	

Level of awareness of environmental issues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very aware	15	38.5	39.5	39.5
	Aware	22	56.4	57.9	97.4
	Slightly aware	1	2.6	2.6	100.0
	Total	38	97.4	100.0	
Missing	System	1	2.6		
Total		39	100.0		

Awareness of Env.Issues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very aware	20	48.8	50.0	50.0
	Aware	18	43.9	45.0	95.0
	Slightly aware	2	4.9	5.0	100.0
	Total	40	97.6	100.0	
Missing	System	1	2.4		
Total		41	100.0		

Q1 and Q2

Statistics

		Level of awareness of environmental issues	Level of awareness of environmental issues
N	Valid	39	38
	Missing	0	1
Mean		1.90	1.63
Median		2.00	2.00
Mode		2	2
Std. Deviation		.598	.541
Sum		74	62

Q3

Statistics

Awareness of Env.Issues

N	Valid	40
	Missing	1
Mean		1.55
Median		1.50
Mode		1
Std. Deviation		.597
Sum		62

Wilcoxon Signed Ranks Test Q1-Q2

Ranks

		N	Mean Rank	Sum of Ranks
Q7 - Q7	Negative Ranks	10[a]	6.70	67.00
	Positive Ranks	2[b]	5.50	11.00
	Ties	26[c]		
	Total	38		

a. Q7 < Q7

b. Q7 > Q7

c. Q7 = Q7

Test Statistics[b]

	Q7 - Q7
Z	-2.352[a]
Asymp. Sig. (2-tailed)	.019

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test