Towards the development of a framework for incorporating sustainability education in the built environment curriculum

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Abstract

Many proponents believe that there is a linkage between the green agenda and built environment (BE) education. It is increasingly recognised that the BE education curriculum should incorporate sustainability and produce graduates that are confident of taking care of the environment without damaging it for future users. Achieving education for sustainable development within the quantity surveying curriculum and more generally in BE curriculum will require an exploration of the general definition of sustainable development and its three spheres; economic, environmental, and social. In addition, one must acquire knowledge of regulatory and technological issues that encompass both the parts and the whole in dynamic interaction. Clearly, universities operating in the BE field have a vital role in shaping the future pattern of practice and policy in relation to the sustainability agenda. So, it is vital to map the curriculum towards sustainability. This research has been developed in response to the growing need of education for sustainable development. Whilst the study identifies the quality and quantity of sustainability-related materials within existing BE curriculum, future research is needed to develop a modular framework for further integration of sustainability education in BE programmes. This framework could serve as an evaluation and a benchmarking tool for those who engage in developing the content of BE degree programmes.

INTRODUCTION

The sustainability revolution, which occurred over three decades ago, has culminated in the realisation that the world runs the risk of unsurmountable challenges if it does not embrace sustainability (cf. Miller *et al*., 2014). From the perspectives of proponents, the concept, which hinges on the future of humankind and the relationship between society and its natural environment, offers economic, socio-cultural and ecological benefits (Crofts, 1999). These benefits, as argued by proponents, manifest in several indicators. These include: poverty eradication or reduction; gender equality; economic growth with creation of jobs and promotion of strong economies; better standard of education and healthcare particularly in relation to water quality and better sanitation; and resilience in terms of the effects of climate change among other indicators (Olsen and Fenhann, 2008; Prüss-Üstün, 2008; David *et al*., 2013). Accordingly, sustainability has become very popular and engaged the attention of policy makers and implementers, as well as industry players across all disciplines. Indeed, Bell and Morse (2008) note that sustainability has become central to development discourse in a manner that only few development initiatives or research proposals are able to secure sponsorship or funding without the words “sustainability” or “sustainable” appearing in such proposals to funding agencies.

Although various disciplines have adopted and are adopting the principles of sustainability, the attention on sustainability and its application within the built environment continue to intensify. This is because of the crucial role the built environment plays in the destruction of natural, human and social capital (Holdsworth & Sandri, 2014). For example, it is estimated that buildings and the building industry consume 32% of the world's resources including between 40-50% of energy and up to 16% of the water used annually worldwide (Iyer-Raniga *et al*., 2010; Holdsworth & Sandri, 2014). Further, the building industry produces about 40% of waste that goes to landfill and accounts for 40% of air emissions (Holdsworth & Sandri, 2014). This implies that the intensification of the application of sustainability principles within the built environment is justified and there is a need for mechanisms for their implementation. At the heart of any strategy to implement or promote sustainability principles within the built environment is a well-crafted sustainable built environment education curriculum for stakeholders, such as built environment students and professionals (Iyer-Raniga *et al*., 2010). This is to equip graduates from higher education, professionals and other stakeholders to use and manage the built environment sustainably.

However, such a sustainable built environment education curriculum requires a suitable framework given sustainability education is unique, differing immensely from other, more conventional modes of education (Holdsworth & Sandri, 2014). This is compounded by the fact that knowledge obtained from sustainability science and related fields to support transitions to sustainability remains a critical theoretical and empirical question for basic and applied research (Miller *et al*., 2014). Although several studies (Iyer-Raniga *et al*., 2010; Iyer-Raniga and Andamon, 2012; Holdsworth & Sandri, 2014; Altomonte *et al*., 2014; Conte, 2016) have examined the link between sustainability and the built environment education in an attempt to prescribe a sustainable built environment education curriculum. The development of comprehensive framework for the incorporation of sustainability in the built environment education remains elusive.

Consequently, this study aims to contribute to the development of a comprehensive framework to incorporate sustainability into the built environment education curriculum. The concept of Sustainable Development within the Construction Industry is explored and literature relating to the importance and challenges of embedding sustainability in built environment education is explored before a series of four case studies are undertaken appraising existing RICS accredited QS degree programmes to appraise levels of sustainability inclusion within the curriculum. From this analysis, a modular framework for integration of sustainability education in built environment programmes is proposed.

SUSTAINABLE DEVELOPMENT AND THE CONSTRUCTION INDUSTRY

Sustainability and sustainable development (SD) are inextricably linked. Environmental, industrial and manmade disasters continue to trouble human existence. It is generally accepted that some natural disasters caused by forces of nature are inevitable. However, proponents in this field believe that we must do something about manmade and environmental hazards such as the threat of global warming caused by human action or inaction (Spence & Mulligan, 1995; Azapagic, Perdan & Shallcross, 2005; IPCC, 2014; Yilmaz & Bakis, 2015; Zaid, Jones & Holgate, 2017). Apart from being the morally acceptable thing to do, the current generation as the custodian of the built environment owe it to future generations to preserve and maintain the natural habitat. This was the main theme in the

report of the World Commission on Environment and Development (Brundtland, 1987), and several global events thereafter have reinforced the idea of SD (Ekundayo *et al.*, 2011).

According to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5), global warming otherwise referred to as climate change is caused by the emission of greenhouse gases (GHGs) mainly carbon dioxide (IPCC, 2014). There are different aspects to sustainability (Son *et al*., 2011; Gan *et al*., 2015; Yilmaz & Bakis, 2015), but the fundamental principle is for all development activities to be both less resource-intensive and less environmentally damaging (Spence & Mulligan, 1995; Sev, 2009). The crucial elements often referred to as the triple bottom line of SD are society, environment and economy. While the topic of sustainability remains highly contested, it is evident that the earth finite resources must be managed effectively whilst at the same time reducing GHG emissions accumulating in the biosphere. This is necessary for the survival of the earth and its current and future occupants.

As mentioned by Spence and Mulligan (1995), the rapid depletion of the world's finite resources and the build-up of GHGs in the habitat leading to global threat of climate change implies that the construction industry has a vital role to play in achieving a sustainable future. Infrastructure and its associated developments are key to economic growth and global competitiveness. The construction industry and its extensive workforce help to build resilient infrastructures and sustainable (built) environments that we all rely on. This multi-billion pound industry is however one of the largest exploiters of natural resources and a major producer of GHGs such as embodied and operational carbon. Buildings and infrastructures make use of raw materials produced from mineral and natural resources. The extraction, production, transportation and recycling or disposal of these raw materials, are energy intensive. In addition, the buildings lifecycle, from cradle to grave i.e. from construction to demolition, have negative impacts on the environment (Tan *et al*., 2011).

According to Yilmaz & Bakis (2015), buildings use 45% of world energy and 50% of water. In a similar study, Dixon (2010) highlights the environmental hazards caused by buildings such as 23% of air pollution, 50% of greenhouse gas production, 40% of water pollution and 40% of solid waste in cities. As well as buildings contributing to 50% of raw material consumption, the waste produced by the construction industry varies between 15 and 50% as reported by Sev (2009). Clearly, the construction industry is resource-intensive and a major polluter of both built and natural environments such that sustainability is now a key concept in development thinking at all levels. This led to the assertion by Sev (2009) that the significance of the construction industry in achieving economic growth, social progress and effective protection of both built and natural environments cannot be overstated.

IMPORTANCE AND CHALLENGES OF EMBEDDING SUSTAINABILITY IN BUILT ENVIRONMENT EDUCATION

The purpose of this section are twofold, that is, to review the importance and challenges of embedding SD in built environment (BE) education. The construction industry has a vital role to contribute to SD as the major energy, mineral and natural resources consumer. Construction industry is responsible for the development of nations and buildings as well as their associated infrastructures have numerous economic, social and environmental impacts. According to Son *et al*. (2011) the construction sector has the greatest impact on

national economies and the environment. Structures can last for several decades and in some cases centuries. However, sustainable construction is a notion that cannot materialise without a solid understanding and knowledge of sustainability concepts.

Whilst the construction industry generates many benefits to the built environment and society at large, the pressure of its activities on the natural habitat is alarming. Depletion of the biological and mineral resources many of which are non-renewable and deterioration of the physical environment such as loss of soil, forests and agricultural land, as well as increasing air pollution, global temperature and sea level rise are only a few examples. The ambitious targets set by the UK Government for all new domestic and commercial buildings to be zero carbon by 2016 and 2020 respectively is a step in the right direction to curb the irreversible damage being done (Zaid *et al.*, 2017). Consequently, we cannot leave this to our industry thinkers and policy-makers alone to proffer solutions. Perhaps, we should focus more on BE stakeholders' particularly higher education institutions (HEIs) that educate construction industry professionals. The huge contribution that HEIs can make in achieving SD underlines the importance of embedding sustainability in BE education. Whilst Government initiatives are having a positive impact, it is believed that HEIs are imperative in driving the sustainability agenda forward (Cotgrave & Kokkarinen, 2010; Sutrisna & Rowe, 2012; Fukukawa *et al*., 2013; Brennan & Cotgrave, 2014).

HEIs have been striving to incorporate sustainability into their BE curriculum in order to maintain the currency of their programmes. This is reinforced by the need for the education sector to ensure that construction graduates are fit for purpose and able to lead the design, construction and management of sustainable structures (Sutrisna & Rowe, 2012). BE professionals make decisions and engage in activities that can lead to physical alteration of the natural environment. This has led to the surge in interest in sustainability and calls for BE schools to educate economically aware, socially responsible and environmentally conscious graduates. Although this has been a topic of discussion for much longer, for example the UN declaration for the decade of education for sustainable development (ESD) 2005 to 2014 (UN, 2002), the development of a framework to embed sustainability into BE curriculum is long overdue.

Despite the growing importance of ESD in HEIs around the world, its implementation in the construction industry and BE sector remains a challenge (Brennan & Cotgrave, 2014). In a study carried out by Fukukawa *et al*. (2013), barriers to the development of an SD curriculum for degree programmes were identified. These include time constraints on the part of teaching staff along with their perceived lack of expertise about SD, the need for a coherent strategy at the school level, attitudes towards ESD and lack of university initiatives of this kind. Earlier, Cotgrave & Kokkarinen (2010) classified the barriers into organisation and funding of UK universities, academic indifference and approach to teaching and assessment, and lack of communication between industry and academia. While the barriers are being addressed by HEIs that promote ESD, there is need for a framework to enhance the creation, implementation and delivery of ESD programmes in BE schools. Cotgrave & Kokkarinen (2010) describe this as a sustainability literate construction curriculum. The proposed framework will address the perceived lack of action from HEIs and will ensure that sustainability literacy is fully realised in practice.

PREVIOUS RESEARCH ON SUSTAINABILITY EDUCATION

Sustainability is often perceived as a political propaganda inspired by environmental consciousness and driven by socio-economic factors. Yet, the importance of ESD in the construction curriculum is widely accepted. Sustainable development, green supply chain management and sustainable construction are just a few of the lexicons bandied around in the construction industry and other sectors as a means to an end, a way to achieve sustainability. As such, different studies over the years have examined the nomenclature of sustainability, but limited research exist on how this concept can be integrated into BE curriculum (Cotgrave & Kokkarinen, 2010; Sutrisna & Rowe, 2012; Fukukawa *et al*., 2013).

A recent study by Tan *et al*. (2017) investigated the extent in which sustainable development is embedded in the construction related curriculum based on the perception of quantity surveying students. The findings from this study and a review of extant literature revealed that students have basic/limited knowledge of sustainability despite the high importance placed on sustainability education from different directions. This supports findings from previous studies, which suggest that the level of inclusion of sustainability in the curricula appears to be low (Azapagie *et al*., 2005; Cotgrave & Alkhaddar, 2006; Perera & Pearson, 2011; Ekundayo *et al*., 2011). In the light of the above, it was suggested that there is the need for a framework for embedding sustainability education in the curriculum.

Fukukawa *et al*. (2013) examines the implementation of ESD within a business school through a case study approach. Similarly, Ekundayo *et al*. (2011) attempted to map sustainability education to construction related curricula using a case study of quantity surveying degree programme. Consequently, this led to the development of a sustainability framework relevant to quantity surveying degree programme. The framework groups the sustainability-related knowledge areas relevant to QS education into six main categories (such as background knowledge and concept, policies and regulations, environmental issues, social issues, economic issues, technology and innovation) with several subcategories. It is on this basis that this study becomes imperative with a view to develop a framework for embedding sustainability education into BE curriculum.

Sustainability is a global issue and human building activity has huge ramifications for current and future generations. A truly sustainable project, which is economically viable, socially acceptable and environmentally friendly, requires a concerted effort. Construction professionals such as Architects, Quantity Surveyors and Project Managers, educated in BE schools, are tasked with the responsibilities of designing, costing, constructing and managing these structures. BE professionals thus have an important role to play in creating a healthy built environment, juxtaposed within the natural habitat, which are affordable and accessible. To this end, this research would be of great value and would eventually lead to the development of a future paradigm for BE curriculum design.

RESEARCH METHODOLOGY

Previous research established that there is indeed a discourse and a gap on how the sustainability issues are taught in built environment programmes in the UK. The current research sought to develop a framework that satisfies the aspirations of the various stakeholders (i.e. students, universities, professional bodies, industry, etc.). The main research instrument used to achieve this include case studies. Detailed case studies of four

universities, which the authors have identified as A, B, C & D were used to generate a sustainability mapping for the study.

The case studies include examination of four RICS accredited QS degree programmes. The curricula of these programmes (module specifications, module handbooks, programme specifications) were analysed to establish the common thread in all the programmes in the four universities. The ensuing outcome of the analysis was then verified for accuracy and consistency with programme directors and module tutors responsible for delivery of these programmes and with some recommended industry liaison board members of the various universities involved.

Case study uses a variety of data collection techniques, such as questionnaires, observations, interviews and published documentary information etc. (Yin, 1994). The advantage of using this method of data collection is that it takes into account the numerous literatures available by narrowing down the scope in order to seek understanding of a particular phenomenon, which is the aim of this study. The case study will be analysed from quantitative (i.e. descriptive analysis) and theoretical point of view to create the sustainability mapping. The latter involves searching-out of underlying themes in the materials being analysed and making critical evaluation of the extracted themes (Bryman, 2008).

Case Studies

The four case studies selected were leading QS honours degree programmes in the UK all accredited by the RICS. The QS undergraduate programme is either studied as BSc (Hons) Full Time for 3 years full-time or 4 years sandwich. In Year 1, (otherwise known as Level 4), studies focus on the principles of knowledge on which quantity surveying is based including undertaking a UK-based residential field study visit. Year 2 (or Level 5) concentrates on the role of the Quantity Surveyor in practice and prepares students for work in the optional placement year. Students are strongly encouraged to undertake a placement year as it gives them the opportunity to put into practice what they have learnt in the first 2 years of their study before progressing onto the final year. In Final Year (otherwise referred to as Level 6), the broader role of the Quantity Surveyor is investigated whilst further developing relevant academic skills and undertaking an optional European-based residential study visit.

These four universities are the major providers of QS and construction related programmes and training in the UK, therefore, their programmes have to be sound, up to date and at the fore front of knowledge. This is critical if they are to maintain their absolute relevance well into the future and to keep attracting applicants from within the UK and worldwide. The adequate inclusion of sustainability education into their curriculum is of paramount importance to produce graduates confident of taking care of the built and natural environments. It is therefore necessary to examine the extent of coverage of sustainability within their QS curriculum, which is the focus of this study.

Sustainability Mapping

Ekundayo *et al*. (2011) developed a sustainability framework (see figure 1), which identifies the knowledge areas relevant to the QS degree programme and the profession. The framework, developed based on current and future roles of the professional quantity

surveyor as informed by the sustainability agenda, categorises the sustainability-related knowledge areas relevant to QS education into 6 main categories (high level categories) with several subcategories (low level categories). The curricula (module specifications, module handbooks, programme specifications) of the four universities were mapped against the sustainability framework to evaluate the extent of coverage of sustainability education in these QS degree programmes.

SUSTAINABILITY FRAMEWORK						
HIGH LEVEL CATEGORIES	CATEGORY A - BACKGROUND KNOWLEDGE AND CONCEPT	CATEGORY B - POLICIES AND REGULATIONS	CATEGORY C - ENVIRONMENTAL ISSUES	CATEGORY D - SOCIAL ISSUES	CATEGORY E - ECONOMIC ISSUES	CATEGORY F - TECHNOLOGY AND INNOVATION
LOW LEVEL CATEGORIES	Sustainable development overview and principles Climate change and global warming issues Impact of the construction industry on the environment Sustainable construction concept Role of QS in sustainable development	Changes to Building regulation, e.g. Part L (energy efficiency) and Part F (means of ventilation) Code for Sustainable Homes Energy Performance Certificate (EPC) The Kyoto protocol Relevant EU Directives such as the EU climate policy, EU ETS, etc Climate Change Act Sustainable Construction Strategy Sustainable Procurement Action Plan	Protecting and enhancing the built and natural environments Environmental Impact Assessments (EIA) Environmental Management Systems: ISO 14001 Environmental Assessment Methods: BREEAM, LEED, Green Star Reducing energy consumption, that is, emitted and embodied Reducing greenhouse emission such as methane, carbon, nitrous oxide and refrigerant gases Carbon Agenda (Carbon footprinting, Zero Carbon, Retrofit) Waste reduction principles (recycling, reduction, reuse, effective design) Brownfield development Natural resources, renewable and non-renewable materials Water usage and Sustainable Transportation Plan	Corporate Social Responsibility (CSR) Ethical issues such as ethical sourcing of materials and labour, for instance Equity and social justice Community development and social inclusion Health & safety Employment, training and education Social assessment methods (e.g. Design Quality Indicators, KPIs and benchmarking, etc) Cost Benefit Analysis (i.e. impact of human factors on the community)	Cost planning and management Value management or engineering (cost of alternative materials and designs) Sustainable procurement strategies Feasibility studies Whole-life appraisal/ Life cycle costing Financial incentives (such as subsidies, climate change level, aggregate tax, carbon credit, Brownfield land tax, etc)	Renewable energy technologies (Photovoltaic, Wind Turbine, Geothermal, Biomass, etc) Green Building Materials Rain water harvesting and Grey water collection systems Professional and management software packages such as BIM, etc Modern methods of construction: offsite production, use of precast material, lean construction, etc Passive design methods such as day lighting, intelligent facades, carbon storage and offsetting, etc Supply chain management Effective information control and management (using e-business)

Figure 1. Sustainability framework relevant to QS degree programme (Ekundayo *et al*., 2011)

RESEARCH RESULTS

The sustainability mapping of QS degree programmes, shown in figure 2, reflects the overall coverage of depth and breadth of coverage of the sustainability issues within the four case studies. The outcomes of the mapping illustrate how the sustainability issues are embedded in the modules, specifications and the handbooks of the four case studies. As can be seen from figure 2, all the pre-determined sustainability issues are present in all four universities, however, how these attributes have been embedded are inconsistent across the four case studies, and more alarmingly attainment often achieved in isolation, for instance through one specific module. Rather than through a more considered and holistic curriculum design that ensures sustainability and sustainable development are robustly addressed in contexts relevant to the profession.

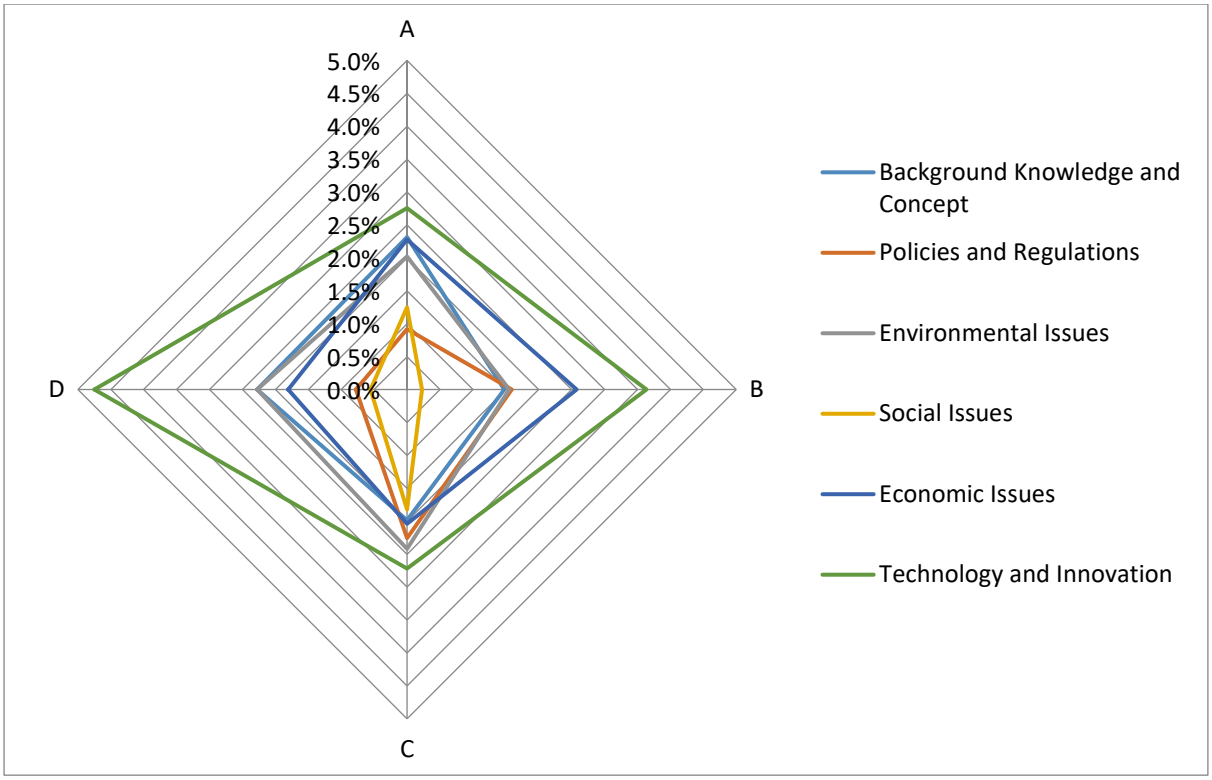

Figure 2. Sustainability mapping (high level categories) of QS degree programmes

DISCUSSION AND CONCLUSION

The quantitative results illustrate that the curriculum, at least in these four institutions, emphasises technological and innovation aspects rather than broader sustainable development issues and more than any other categories in the framework. While this is interesting, it is not so surprising as subjects such as renewable energy technology, BIM, green supply chain management and passive design methods among other things have become very popular and central to the sustainability discourse. This finding is interesting because more than often, sustainability-related literature (such as Spence & Mulligan, 1995; Azapagic *et al*., 2005; IPCC, 2014; Yilmaz & Bakis, 2015; Zaid *et al.*, 2017) accord greater emphasis to the background knowledge and concept subject areas as revealed in the literature.

As the mapping was done against QS degree programmes, it would also have been expected that economic issues such as cost planning, value management, sustainable procurement strategies, and whole-life appraisal be covered in the curriculum at a higher level than any other sustainability issues in the framework. Nevertheless, this more or less emphasises the role of technology and innovation in sustainability implementation. Also, technology is now often use to enhance the role of a quantity surveyor. The somewhat disturbing part of the findings however is that economic issues are covered at a relatively low level in some institutions, and this cannot be right. Further investigation is thus required in this regard.

The coverage of environmental issues and policies and regulations in the curriculum is plausible in the light of previous work and perspectives of proponents in the field such as Bell and Morse, 2008; Olsen and Fenhann, 2008; PrÜss-ÜstÜn, 2008 and David *et al*., 2013. However, the very low coverage and emphasis on social issues is not so surprising.

Literature that discuss issues such as corporate social responsibility, ethical issues, equity and social justice, cost benefit analysis and social assessment methods as an important part in the sustainability discourse are rare. Consequently, this is reflected in the very low (and in some cases non-existence) level of social issues in the QS curriculum.

Generally, the above findings support results from previous studies like Perera & Pearson (2011) and Tan *et al*. (2017). Sustainability may be evident across only 0.5-4.5% of the curricula of Quantity Surveying programmes, at least in these four institutions, and incorporated at a basic level only. This is in spite of the need and relentless call for a framework for embedding sustainability education in the curriculum as the literature review suggested (Azapagie *et al*., 2005; Cotgrave & Alkhaddar, 2006; Ekundayo *et al*., 2011).

Professional institutions are increasingly placing more emphasis on broader issues of sustainable development, and there have been explicit requirements of mapping BE curriculum against addressing sustainable development issues. As such sustainable development should be seen in such neat categories of competence areas as identified in the sustainability framework. Understanding and addressing sustainable development is, however, a good problem. Thus, this calls for multi-disciplinary and often innovative ways of teaching and learning the 'subject'. There needs to be some acknowledgement of this, and also progress made especially in encouraging multidisciplinary approaches to education for sustainable development. This research agrees with previous work (e.g. Ekundayo *et al*., 2011) that a concerted effort across the disciplines is needed in order to integrate sustainability issues into BE programmes. Including the views and input from other stakeholders such as students, professional bodies and industry practitioners in this regard is also of paramount importance.

Findings from the literature review and relevant work previously discussed, as well as this study, indicate that there are challenges to embedding sustainability in BE education. This study is part of a larger research within the education for sustainable development, which aims at diffusing sustainability into the curricula of BE programmes in UK universities. While this research focussed mainly on mapping the inclusion of sustainability within the quantity surveying curriculum, it is evident further investigation is now required to appraise the inclusion of sustainability within other BE degree programmes. Furthermore, whilst the study identifies the breadth and depth of sustainability-related materials within existing curriculum, future research is needed to develop a modular framework for further integration of sustainability education in BE programmes. The framework could serve as an evaluation and a benchmarking tool for those who engage in developing the content of BE degree programmes, policy makers and implementers, as well as industry players across all disciplines.

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