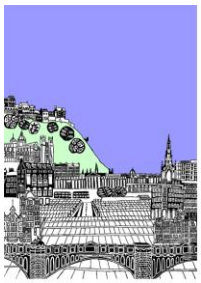

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Education for Sustainable Development of the Built Environment: Problem-Based Learning Approach for Embedding Sustainability

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Abstract:
Sustainable development (SD) is a fundamental pillar for the socio-economic welfare of Egypt, as with every other nation. However, the rapid growth of the country limits the resources required to meet its national demands, particularly in the built environment (BE) sector. The building industry is considered the largest resource-consuming sector that has direct impact on the country's economic stability and growth. Regrettably, education for sustainability (ESD) in Egypt is currently limited; compared to the rapid progress and momentous ESD initiatives worldwide. There is significant lack of training that prepares various stakeholders in the BE to embed holistic SD at all scales; buildings, neighbourhoods, and cities. In response, tailored training programmes are developed by a British Council-funded project; Building Capacity for Sustainable Development of the Built Environment (BC-SDBE), to promote sustainable design, planning and performance at all scales of the BE. The training programmes emphasise a balanced approach to environmental, socio-economic and technical aspects for sustainable built environments. This paper aims to argue the challenges that drove this capacity-building initiative and set out potential approaches to educate and 'train the trainers' in cutting-edge strategies for embedding SD strategies in the BE in Egypt.

Keywords: Education, Sustainable Development, Built Environment, Critical Thinking, Problem-Based Learning

Introduction and background

The anthropogenic impacts on the earth's ecosystems and its direct implications on climate change have pushed Sustainable Development (SD) as a priority in many nations' strategic plans. Increasing global greenhouse gas (GHG) emissions, combined with the widespread economic impact of global commodities such as coal, natural gas and oil and their effect on energy prices, education for sustainable development (ESD) is a key vehicle against which both energy consumption can be reduced and GHG emissions curtailed. It is fundamental to steer education towards the conservation of energy in the built environment (Taleghani *et* al., 2011). Hegarty (2008) in Holdsworth & Sandri (2014) argue that sustainability education must equip learners with capabilities to reflect, think critically and problem solve accordingly in order to make timely decisions in response to the issues of depleting resources. Hence, developing critical and creative thinkers who feel empowered to act as responsible citizens is key to ESD (Sewilam *et* al., 2015).

International directives and legislations acknowledge that ESD at pre-and post-professional levels play major roles in embedding sustainability in most disciplines (Altomonte, 2012). The Sustainable Development Strategy (SDS) for Egypt has been recently introduced with three main goals to be achieved; economic development, competitiveness of markets

and human capital (MOPMAR, 2016). Hence, adopting ESD in the Egyptian educational system is paramount for the SDS goals to be achieved by 2030. As the building industry is considered one of the largest industries in Egypt, contributing with 33.9% of the total National Gross Income (CAPMAS, 2014); this requires strategic planning to ensure principles of sustainability are learnt and applied in this important and dynamic sector.

"Education for Sustainable Development allows every human being to acquire the knowledge, skills, attitudes and values necessary to shape a sustainable future" as defined by the UNESCO (2014). The UK Quality Assurance Agency for Higher Education (2014) defines ESD as "the process of equipping students with the knowledge and understanding, skills and attributes needed to work and live in a way that safeguards environmental, social and economic wellbeing, both in the present and for future generations". Notably, education that embeds holistic sustainability has gradually evolved at undergraduate (UG), postgraduate (PG) and professional levels in many countries. Altomonte *et* al (2013) argue that the perception of sustainability has become more core on the agenda of higher education (HE) in built environment-related disciplines where it has become an overarching principle for many educational programmes. A survey undertaken in more than 30 countries by the Environmental Design in University Curricula and Architectural Training in Europe (EDUCATE), found general inconsistency in approaches to embedding sustainability in academic curricula (Altomonte *et* al., 2015) depending on each country's priorities.

In Arab countries, ESD initiatives have been generally dispersed in HE programmes. Existing pre and post-professional training in Egypt have not satisfactorily addressed aspects of sustainable design and planning. This confirms the necessity to educate and train UG and PG students, practitioners, academics and professionals in the construction sector to reduce the gap in the knowledge and skills in aspects of sustainability of the built environment. As a result of preliminary skills-needs analysis, Building Capacity for Sustainable Development of the Built Environment (BC-SDBE) project, subject of this study, facilitates ESD to address this skills gap through its training programmes. The project partners consider ESD as learning, acquiring, and applying the principles of SD to the design and construction of the built environment. The ultimate aim is to build capacity in education, research, innovation, and exploitation of state-of-the art SD strategies from a holistic sustainability approach to support meeting Egypt's socio-economic demands. The anticipated project impact is to bridge the gap between the developing advancements in ESD globally, the national plans set out for Egypt's economic development, and the demanding professional development in SD required in Egypt's construction labour market.

The aim of this paper is to emphasise the drivers to this capacity-building initiative and set out potential approaches to educate and train diverse stakeholder groups in state-of-the-art strategies for embedding SD strategies in the BE in Egypt. The study advocates the need to develop critical thinking as a catalyst for effective education in this field. It identifies Problem-Based Learning (PBL) as a viable pedagogic approach to embed holistic sustainability in learning and practice. The outcome of the research is the development of a robust framework for ESD grounded on PBL as a main approach supported by the constructive alignment of teaching and learning activities, intended learning outcomes (ILOs), and assessment activities to develop thorough and systematic deep learning (i.e. learning with understanding).

Initiatives for sustainable development of the built environment in Egypt

Initiatives to address sustainable design and construction of buildings have recently received significant support in Egypt and have been integrated into building codes, and standards. In response to the drive to build and reinforce environmental sustainability in the building sector in Egypt, a public reviewed version of the Green Pyramid Rating System (GPRS) has been introduced in 2011 without a definite plan for the release of the final rating system. Reasons for this delay may be the voluntary nature of this initiative besides the lack of training available to produce qualified building assessors. It is expected that the GPRS will shortly require compliance by professionals of all disciplines engaged in the design, procurement, construction, and management of the built environment in Egypt. The GPRS is a whole-building approach to sustainability that recognises performance in seven key areas: Sustainable Sites Development, Water Efficiency, Energy Efficiency, Materials and resources, Indoor Environmental Quality, Management, and Innovation and Design Process (HBRC, 2011). In order to stimulate and activate the GPRS, educating and training students, architects, engineers, practitioners and professionals who will employ this rating system in their planning, design and construction and environmental performance assessment of buildings is vital. As asserted previously, a significant gap exists in current curricula taught at UG and PG levels and its direct link to market needs that fulfil sustainability demands outlined by Egypt's SDS.

The SDS identifies various challenges for effective technical education and training. Of those challenges; the necessity of effective integration of technical education, vocational training and other educational forms (MOPMAR, 2016). In anticipation of this, several public and private HE providers in Egypt introduced UG and PG programmes to integrate sustainability in the curricula. Salama & Amir (2005) asserted in a study concerning trends in Arab architectural education that only 2 universities in Egypt facilitated Sustainability and Environmental Consciousness related courses at UG levels (Cairo University and Misr International University) in the form of standalone modules that might be core or optional. Other HEIs have then introduced sustainable and environmental design at PG level while others introduced those aspects as either core or optional modules at UG levels. Of those HEIs that have taken a significant initiative to build capacity in sustainability, Ain Shams University, Cairo University, Arab Academy for Science, Technology and Maritime Transport, the British University in Egypt, and Misr International University are the most acknowledged ones. Recently, Ain Shams University (ASU), the main BC-SDBE partner institution, introduced an Environmental Architecture and Urbanism UG programme. This programme provides a grounding to the theory and practice of sustainable design in architecture and urbanism. However, one sustainability-specific UG programme besides a few PG programmes at several HEIs could not accommodate for suitable and timely advancement of ESD in Egypt.

Another initiative introduced in 2011 in Egypt is the Education for Sustainable Development beyond the Campus (EduCamp) Tempus project which aimed to promote and implement ESD in Egypt nationwide and within all education levels. The project developed ESD resource kits for schools and developed a School Teachers' Training Programme to support teachers' classroom activities for SD (EduCamp, 2011). However, the impact of this initiative has not been quantified yet, hence, Sewilam *et* al (2015) suggested for this to be measured; a longitudinal study to assess the impact on teachers and trainers who have applied their training to practice would be essential. Hence, BC-SDBE initiative aims to develop a well-rounded and interdisciplinary knowledge base of sustainability principles in theory and its application in practice. The training and educational programmes focus on

bespoke mechanisms for sustainable design, planning and performance of buildings, neighbourhoods, and cities. The programmes facilitate transformative learning to implement a balanced and strategic approach to environmental, socio-economic and technical aspects of designing a sustainable built environment in the Egyptian context. The BC-SDBE project methodology proposes a viable framework for achieving sustainability in the BE supported by proactive participation of stakeholders in the built-environment-related disciplines. This is in the form of stakeholder meetings and focus groups to outline the specific needs and demands in the construction labour market.

One of the lessons learned from EDUCATE is that a simultaneous bottom-up and top-down approach should be adopted to support the successful implementation of sustainability and energy efficiency in education and practice of design (Altomonte, 2012). Effective stakeholder participation promotes grass roots interest within the learning community that would work in tandem with top-down approaches. Through consultations with academics in the discipline, educators in HEIs in Egypt need to adopt and champion a change in attitude from perceiving sustainability education as an 'add-on' to "a unique educational concept that challenges conventional modes of education and requires new methods of integrative learning" (Barth & Michelsen, 2013 p106). Those new methods require developing critical and analytical skills to enable learners to confidently apply theory to practice. Hence, innovative pedagogical methods, course structures and content, learning and outcomes and methods of delivery should facilitate deep learning and develop problem solving skills. Those pedagogical methods would not only enable learners to acquire knowledge but will support the process of applying theory to practical, real-life scenarios.

Education for sustainability of the built environment

In order to implement sustainability in the built environment, 'training the trainers' can be seen as a first, but fundamental step in raising awareness, embedding sustainability-related knowledge, and the role education plays in developing a more sustainable built environment. One of the core principles underpinning ESD is the development of 'critical thinking skills, analytical skills, empathetic capacity and the ability to be an effective person who can take action to achieve desired development introducing education for sustainable development outcomes' (Tormey 2003, p. 2). The current study proposes a two-step transformative pedagogic approach to 'train the trainers'; developing critical thinking skills, to subsequently apply and use in problem-based learning for effective ESD in the built environment.

First: Critical thinking skills as a basis

Critical thinking is a crucial skill that improves attention and observation, encourages more focussed reading and writing skills, and helps develop analytical skills, which, in turn, support higher levels of attainment (Pithers & Soden 2010). Developing critical thinking skills has positive impact on learners' professional life where they are able to work with greater precision and accuracy in diverse tasks, besides performing well at problem-solving and project management tasks (Jeschofnig, 2014). Critical thinking demands effective problem solving and communication skills using self-directed and self-disciplined thinking (Paul & Elder, 2008). This skill should also be developed in a student-centred learning environment. Student-centred learning essentially puts learner responsibility and activity at its heart with the teacher acting as a facilitator and mentor instead of conventional 'teacher-controlled' learning (Cannon & Newble 2000). Student-centred learning facilitates flexible learning environments which can occur anywhere and at any time if supported with proper technology.

Davidson (2009) suggested a threefold strategy for developing critical thinking in learners. The first stage is to make learners aware of the cultural assumptions that inform the particular approach to criticality in the SD discipline. Stage two is for educators to appreciate the different approaches to knowledge acquisition in different cultures (e.g. Western culture versus Eastern culture). Once those preliminary stages have been elucidated, introducing the particular techniques and mechanisms for critical approaches in thinking, reading, and writing could start. Those techniques and mechanisms should be made explicit to all learners to ensure a smooth start in critical thinking and problem solving. Notably, problem solving stages often entail errors, uncertainty, and possibilities of failure. Research (Pithers & Soden, 2010) assert that such a skill could not be taught in separate courses, albeit, it should be developed during the course of teaching subject-matter learning material. Some research advocates problem-based learning as a method that could be adopted by teachers to enhance students' thinking skills (Pithers & Soden 2010; Allison & Pan 2011). The following section introduces the second step of this pedagogic approach; Problem-Based Learning.

Second: Problem-Based Learning (PBL) for embedding sustainability

Lehman *et* al (2008) explain Sustainable Development as 'a continuous process that requires a balance between (the emergence of) problems and our capacities and capabilities to solve these problems.' Hence, in response, an approach suggested in designing and planning the module sessions for SD is Problem-Based Learning (PBL). Research on PBL assert that this approach makes students more proficient at problem-solving, group working and critical analysis (Allison & Pan 2011). Research studies argue that problem-based learning (PBL) could be considered a key vehicle to developing students' critical thinking skills (Pithers & Soden 2010, Roberts 2007, Savin-Baden & Major 2004). Moreover, PBL is acknowledged as one of the forms of active learning where learners are active participants and independent critical thinkers enabled by the tutor who facilitates opportunities for learning through open-ended situations and problems (Savin-Baden & Major 2004). PBL approach is student-centred and has been successfully incorporated in the built environment discipline. This approach focuses on key problems or issues within professional practice which would require students to undertake some activities to learn from the problem (Cannon & Newble 2000). Research in PBL assert that this approach makes students more proficient at problem-solving, group working and critical analysis (Allison & Pan 2011). In the context of ESD, PBL would be attuned to BC-SDBE training programmes, where real life problem scenarios are transformed into trigger questions that would be addressed.

PBL approach would tend to apply Bloom's revised taxonomy for educational objectives which identify 6 levels of cognitive skills: remembering – understanding – applying – analysing – evaluating – creating (Biggs & Tang 2007). A taxonomy of PBL methods introduced by Barrows (1986) suggested a combination of varieties in use for PBL. Barrows suggested 'lecture-based cases' where 'students are presented with information through lectures and then case material used to demonstrate the information' (Barrows 1986 cited in Savin-Baden & Major 2004). In fact, well-designed problem-based curricula encourage learners to think critically about the content instead of being taught a body of knowledge in lectures and tutorials only (Pithers & Soden 2010). It is important to make students realise that knowledge could be learned in different forms and to help them distinguish between explanatory knowledge, descriptive knowledge, procedural knowledge and personal knowledge (Savin-Baden & Major 2004). To develop a problem for PBL in practice, Savin-Baden & Major (2004) suggest to start with a real life, authentic problem which learners are quite familiar with to

help develop confidence and enthusiasm and to use problems relevant to practice to gain learners' interest. The problems should contain some uncertainty to augment critical thinking and problem solving but should not be too narrow nor over complicated.

Additionally, case-based multidisciplinary and role play learning for students of architecture, engineering and construction in the delivery of sustainability has demonstrated that students develop a better understanding of the SD requirements for project delivery when compared to traditional learning methods (Korkmaz, 2011). In this study, it was found that the students learned that cross collaboration and early integration of the real life scenario solutions are key to achieving the desired sustainable outcomes. When compared to standard learning methods students demonstrated a greater interest in the course material, higher interaction levels which generated deeper learning. Therefore, ESD should combine direct teaching with critical analysis of real life case studies while continuously sharing its knowledge for the benefit of society (Duffy & Rabeneck, 2012).

When designing the learning outcomes of modules for ESD, Bloom's revised taxonomy mentioned previously should be applied in order to ensure a gradual build-up of the levels of learning (Biggs & Tang, 2007). The proposed framework in Table 1 would ensure that learners could achieve the ESD learning outcomes through constructive alignment of learning activities and assessment tasks, and ILOs. Key problems within professional practice which require students to undertake specific activities to learn from real life problems would be set up for assessing PBL, as a shift away from outcome-based examination (Savin-Baden & Major 2004).

Table 1: Constructive alignment of learning activities, ILOs and assessment tasks for sustainable development enhanced training and education

Teaching/ learning activities		Intended Learning Outcomes Module 1: Introduction to Sustainable Development of the Built Environment		Assessment tasks
Lectures. The didactic content of the modules will be explained in lectures, assisted by visual aids, interaction with the students and demonstrations. **Case studies.** Discussions and presentations of real-life examples to demonstrate how the theory studied in the module is implemented in practice. **Set texts.** Core texts will be used as main reference sources to ensure that learners have all the resources for theoretical material covered. **On-line support material.** Materials, and forums will be accessible to students in an e-learning platform. This increases opportunities for distance and needs-related tuition.	→	1. Critically evaluate concepts, methods and outcomes in relation to SD and its short – and long-term implications. 2. Develop a critical position in comparing and assessing SD approaches across all scales of the BE; 3. Demonstrate knowledge and understanding of principles and concepts of sustainability (environmental, social and economic) in the context of building planning and design; 4. Demonstrate familiarity with implications in designing buildings of different and multi functions; 5. Define and identify environmental, and socio-economic attributes of SD in a national and global perspective.	←	Conceptualise and articulate own standpoint with regards to SD in the built environment (reflective journal). Critically assess ideas, concepts and approaches relating to environmental, social and cultural implications of SD in their context / practice (case-based individual essay). Develop analytical and synthetic skills in developing unique but appropriate approaches and tools that are effective and fit for SD purpose (portfolio, presentations).

Table 1 above summarises the constructive alignment of teaching and learning activities with PBL assessment tasks to achieve the Intended Learning Outcomes of the first module/unit in BC-SDBE – Introduction to Sustainable Development of the Built Environment. It is clear from

the above model that critical thinking skill is highlighted in the process of achieving the learning outcomes through PBL tasks and activities.

Conclusion

Ultimately, for Egypt's Sustainable Development Strategy to be successfully implemented and exploited the Egyptian educational system ought to adopt ESD as the cornerstone. HE and research institutions should provide sustainability-focused education and training tailored to various target groups. Several initiatives have been introduced in Egypt in the last decade that aimed to promote sustainability in the built environment, but with no tangible impact yet. The BC-SDBE, as a capacity-building initiative aims to provide learners with a solid grounding of knowledge and understanding of the principles of SD, both in theory and practice. The objectives are twofold; first: to analyse and learn from best practice of educational curricula that integrate sustainable design in the BE whilst linking to the particular market needs and the professional demand in practice; and second: introduce a new framework for training and professional development based on the notion of tailored, adaptable and blended programmes adopting PBL as a pedagogic approach. Learners are engaged in real life case studies to support and develop critical evaluation of available and innovative solutions, and reflection as learning approaches. Learners will be encouraged to confidently disseminate their learning experience and knowledge in their profession through partnership with their peers in their communities and practices. They are introduced to new ways of working collaboratively with other stakeholders in the construction industry, including clients, contractors and suppliers. The outcomes of the training programmes are crucial to support the government strategic plans and goals in achieving the overall sustainability of the BE, on the macro and micro levels.

Supporting learners to develop critical thinking skills will be core to BC-SDBE curriculum design and assessment. Trainers / learners will be guided towards a personal transformation of their values, beliefs and understanding of sustainability. They will appreciate the interdisciplinary nature of social, technological, environmental, and ecological issues and be able to relate this to the particular economic, political and legal contexts of their practice. They will be encouraged to reflect and articulate their sustainability standpoint, to become effective at promoting the benefits of SD and promoting sustainable design. Learners will contribute to the preparation of innovative practitioners, who would take proactive rolse in initiating and facilitating sustainability driven developments in multidisciplinary design and construction teams.

The subsequent stage of the BC-SDBE project is a comparative analysis of ESD in the UK and Egypt with an aim of knowledge transfer of lessons learnt from the UK and adapting them to the Egyptian context. To achieve this, government and industry should work collaboratively with academic and research institutions in facilitating the appropriate medium for ESD and providing sufficient funding to ensure appropriate training standards are achieved to support the national SDS. However, it must be noted that the uncertain political climate in Egypt has a significant impact on how ESD initiatives will be perceived and positioned in its social, cultural and political context.

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