

Innovative Technologies: The Educational Challenges

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Abstract: The creation and sustainability of a Smart Economy will require that Innovative Technologies be embraced by key stakeholders. It is therefore imperative that the engineering and scientific communities in both academic and industrial arenas be sufficiently well informed regarding the advantages and limitations of such technologies. Innovative Technologies are frequently underpinned by fundamental advances in Materials Science and Engineering as evidenced by the development and application of novel materials and structures. The goal of the activities being reported here is to demonstrate how a problem-based learning approach can be used to enhance learning of key concepts as related to the evolution and design of materials to fulfil stringent requirements in a diverse range of innovative technologies. A significant component of this work will feature the integration of technology into problem-based learning (PBL) so as to create a more flexible and effective learning experience. The ultimate goal is to enhance the understanding of, and confidence in, novel materials and structures with a view to their application in a number of industrial sectors including medical devices, pharmaceutical, healthcare, food, green technologies, aerospace, and ICT.

Keywords; innovative technologies, smart economy, education, problem-based learning, novel materials and structures.

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1. INTRODUCTION

The work reported here seeks to address a deficit in education pertaining to innovative technologies, and ultimately to the creation and sustainability of a smart economy. The Irish Government has recently published a framework document '*Building Ireland's Smart Economy – A Framework for Sustainable Economic Renewal*', Government of Ireland (2008). As highlighted in this framework document, 'Smart economic growth recognises the interdependence between four forms of capital accumulation that drive the economic and social progress of the nation', namely, human or knowledge capital, physical capital, natural or environmental capital, and social capital, Figure 1.

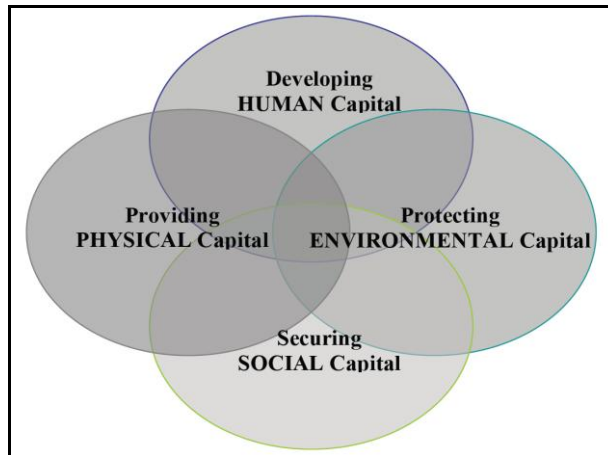


Figure 1 Interdependence between four forms of capital that underpin smart economic growth, (Government of Ireland 2008).

Central to the strategy being advocated in the abovementioned framework document (Government of Ireland, 2008), is ‘the creation of an exemplary research, innovation and commercialisation ecosystem so as to create *The Innovation Island*’. In order to realise this ambition, it is imperative that fundamental issues pertaining to the development of human capital and the associated implications for education be addressed as a matter of urgency.

Globally the level of funding for R&D in Materials Science and Engineering (MSE) has been substantial and whilst this has enabled significant discoveries and the commercialisation of intellectual property, the extent to which such R&D has impacted positively on educational practices in MSE and associated disciplines is questionable. Whilst students in some Universities and Institutes have undoubtedly benefited from research-informed teaching, the creation and sustainability of a Smart Economy will require that such privileges are enjoyed by the majority of students participating in programmes that underpin innovative technologies. This project, with its emphasis on the utilisation of technology-enhanced PBL, is targeted at addressing this deficit by providing students with a more engaging, challenging and rewarding learning experience.

2. METHODOLOGY

Innovative technologies are strategically important in key industrial sectors including medical devices, pharmaceutical, healthcare, food, green technologies, aerospace, and ICT, with Novel Materials and Structures (NMS) underpinning many of the more significant developments in these sectors. For the purpose of demonstrating the effectiveness of technology-enhanced PBL for education in the innovative technologies arena, NMS will be used as the initial test platform. Rapid advances in novel materials coupled with the emergence and growth of convergent technologies have served to expose the inadequacies of traditional teaching methods, particularly in terms of engaging and stimulating enquiring minds, Figure 2. The effectiveness of utilising a conventional PBL methodology has been demonstrated by a number of educators engaged in science and engineering disciplines, (Awang and Ramly, 2008; Harris and Briscoe-Andrews, 2008; Phillips, 2009; Walsh, 2007).

The methodology being employed in this work provides for a more holistic and rewarding educational experience by combining the already proven benefits of PBL incorporating innovative experimental tools, with the latest selection, simulation and interactive software capabilities.

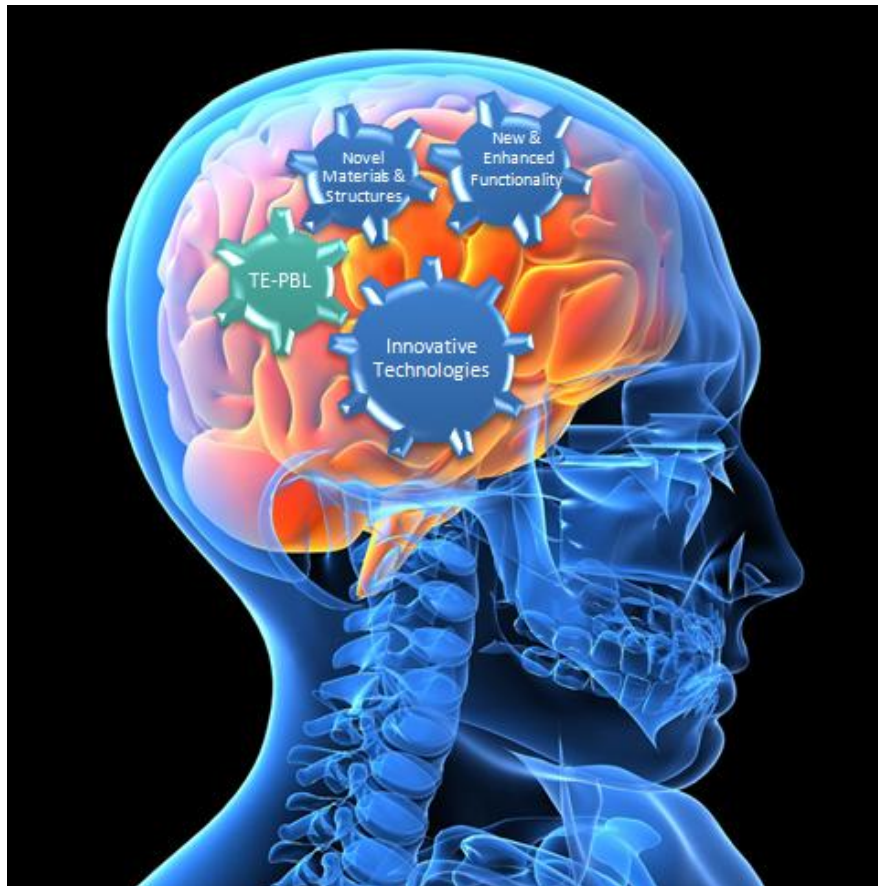


Figure 2 The Motivation for employing technology-enhanced PBL for education in Innovative Technologies, illustrated for the case of Novel Materials and Structures.

Employing this technology-enhanced problem-based learning (TE-PBL) approach to education in Novel Materials and Structures will enable the high degree of complementarity between the latest experimental and software tools to be fully exploited. The selection of the materials to be used during the initial phase has been informed primarily by the degree of novelty of the particular NMS in enabling new and/or enhanced functionality to be achieved (McDonagh and Braungart, 2002; Sanchez et al., 2005; Stuart et al., 2010). The inclusion of NMS having the potential to be commercialised as generic technologies, as defined by Maine and Garnsey (2006), has also been a key consideration. The Novel Materials and Structures being explored in the initial phase of this work include:

- Bio-inspired Smart Materials and Structures
- Shape Memory Materials
- Bulk Metallic Glasses
- Hydrogels
- Eco-Materials

The use of technology-enhanced PBL for education in these rapidly evolving Novel Materials and Structures will not only provide for a more effective learning experience, it will also create an awareness of new opportunities for technological innovations that may be achieved through the exploitation of new and enhanced functionality of products and components, the design of which is informed by quality of life considerations, Figure 3.

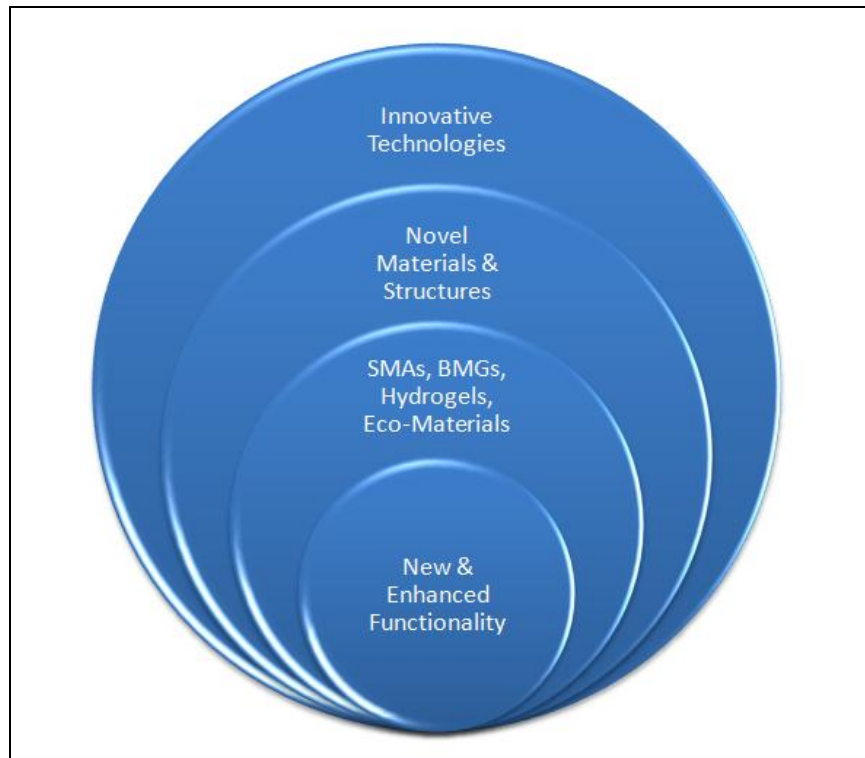


Figure 3 The role of Novel Materials and Structures in achieving New and Enhanced Functionality for exploitation in Innovative Technologies.

Whilst the TE-PBL approach is primarily being pursued in order to achieve a more engaging, challenging and rewarding learning experience for students participating in programmes that underpin Innovative Technologies, a number of very important additional outcomes are also expected to result from the use of this approach. Essentially TE-PBL utilises a set of transferable educational tools to promote Innovative Technologies and the convergence of these technologies using modern interactive and effective learning techniques (PBL and technology). This interdisciplinary educational approach is consistent with that advocated for the exploitation of technological convergence, National Science Foundation, 2002.

The technology-enhanced PBL tools being developed will be implemented by educators to facilitate lifelong learning in engineering, science and technology, whilst at the same time encouraging career paths in Innovative Technologies which are critical for the creation and sustainability of a Smart Economy.

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