Technovation 29 (2009) 738–752

Contents lists available at ScienceDirect

Technovation

journal homepage: www.elsevier.com/locate/technovation

Industry placement, authentic experience and the development of venturing and technology self-efficacy

William A. Lucas [a,*], Sarah Y. Cooper [b], Tony Ward [c], Frank Cave [d]

[a] Gordon Engineering Leadership Program, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 0239-4307, USA
[b] Centre for Entrepreneurship Research, University of Edinburgh Business School, The University of Edinburgh, William Robertson Building, 50 George Square, Edinburgh EH8 9JY, Scotland, UK
[c] Department of Electronics, University of York, York YO10 5DD, England, UK
[d] Lancaster University Management School, University of Lancaster, Lancaster LA1 4YX, England, UK

ARTICLE INFO

Keywords:
Self-efficacy
Technology
Venturing
Industry placement
Authentic experience
Higher education

ABSTRACT

Many governments are keen to see enhanced levels of enterprise and entrepreneurial activity and have encouraged the higher education sector to increase the amount of enterprise education provided to students, particularly in science, engineering and technology disciplines, to prepare them for careers that advance innovation. Whilst university students derive much education and learning from within their principal discipline, significant learning occurs outside the classroom, at home, in social settings and in the workplace. This paper uses data on more than four hundred third and fourth year engineering undergraduates at four United Kingdom universities to explore the relative contribution of a range of experiences in the workplace which affect their venturing and technology self-efficacy. Experiences include different forms of workplace orientation, varying degrees of authenticity of the work they are given relative to their future careers, how students rank their performance and the presence of successful role models. Results show that authenticity, defined as a close relationship between the undergraduate's course of study, feedback on performance, and how well the students felt they had performed, are the dominant predictors of self-efficacy. The paper concludes with a discussion of the need for universities and companies to work together to pay greater attention to the quality of undergraduate placement experiences.

1. Introduction

The development and growth of a strong economy is high on the agendas of many developed nations, a large number of which have experienced marked structural shifts in economic activity over the last 30 years (Cooper, 1999; Prahalad, 1998). Decline in traditional industries has led to government interest in the growth of new technology-based sectors which exploit advances in fields such as electronics, biotechnology and software. In this regard, considerable attention is given to entrepreneurs who form new, high-technology firms, but it is important to note that opportunities offered by new technologies are also being furthered or fumbled by large and small established companies facing volatile markets, the restructuring of supply chains and distribution channels, and the need to continue to scan for useful advances in science and technology (Chesbrough, 2003; Prahalad, 1998). Whether one chooses to call the organisational activity the development of "dynamic capabilities" (Teece et al., 1997), "radical innovation" (O'Connor et al., 2008), "entrepreneurial orientation" (Li et al., 2008; Lumpkin and Dess, 1996), "corporate entrepreneurship" (Stevenson and Jarillo, 1990) or just innovation (Kirzner, 1979; Schumpeter, 1934), the ways that established companies pursue economic advantage in high-technology sectors is as important to national economies as the appearance of new start-ups.

The emergence and success of new technology sectors in both new and established companies is inextricably linked with individuals able to recognise new opportunities and lead their exploitation (Kirzner, 1979; Penrose, 1959; Schumpeter, 1934), and the number and location of those individuals in companies has been changing. Strategic choices, like a decision to enter new markets, were once largely initiated and led by top management (Newbert et al., 2008), and research and the development of new knowledge was dominated by internal research organisations (van der Vrande et al., 2009). As companies are facing broader and more complex pressures in what Chesbrough (2003) refers to as an open innovation, company survival is more and more determined by the acquisition of a vast array of ideas, technologies and other forms of knowledge in its environment.

* Corresponding author. Tel.: +1 617 253 4840; fax: +1 617 324 6901.
E-mail addresses: walucas@mit.edu (W.A. Lucas), sarah.cooper@ed.ac.uk (S.Y. Cooper), aew@ohm.york.ac.uk (T. Ward), f.cave@lancaster.ac.uk (F. Cave).

0166-4972/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.technovation.2009.06.002

Particularly in technology-intensive companies, the capture, evaluation and subsequent communication of important information is widely distributed across company departments by employees with widely varied seniority, in what Ancona and Bresman (2007) call a distributed model of leadership. In an open innovation organisation, even relatively young engineers, who graduate with a current appreciation of technical trends and an appreciation of business opportunities, may play a pivotal role in keeping a company at the leading edge of its industry.

The success of an economy driven by technology entrepreneurship in its broadest sense will increasingly depend upon a steady flow of both entrepreneurs forming new companies, and what appears to be a far greater number of entrepreneurially minded professionals, who as employees of established companies can track technical advances, identify important intellectual property, recognise opportunities and then implement new lines of business (van der Vrande et al., 2009).

1.1. Sources of technical professionals for technology-intensive venturing

In this context the United Kingdom (UK) government, like many others, has supported university-based activities with a particular concern for raising awareness and increasing understanding of enterprise among science, engineering and technology (SET) students and enabling them to develop skills and competences suited to fostering innovative applications of technology in new business ventures (Hartshorn and Hannon, 2005). Whilst university students derive much education and learning from within their principal discipline (Kelly, 1986; Monck et al., 1988; Oakey et al., 1990; Roberts, 1991), significant learning occurs outside the classroom (Rasmussen and Sørheim, 2006), at home, in social settings and in the workplace.

The effect of workplace experience, generally found in the literature (Oakey et al., 1988, 1990; Cooper, 1998; Harrison et al., 2004) to be important, is widely viewed by university instructors as having a consequential impact on undergraduate readiness for the world of work. Indeed, one approach to enhancing the readiness of university undergraduates for innovative technical careers is to introduce forms of education that simulate aspects of work experience. There is growing emphasis on increasing the exposure of science and engineering students to more active and project-based learning (Okudan and Rzasa, 2006; Scheibe et al., 2007) and other forms of authentic experience (Wee, 2004). Given the value of experience, a role of research is to try to determine if and how activities such as industry placements prepare engineering undergraduates for innovative careers by determining what characteristics of their experience strengthen self-efficacy for venturing and, separately, self-efficacy for technology.

This paper begins with a brief overview of work placements, and addresses the literature that supports the central importance of venturing self-efficacy and its determinants for work performance and innovation. The review suggests relevant lessons that should be taken from Social Cognitive Theory (Bandura, 1986, 1997), the importance of self-efficacy in predicting improved work performance in general (Stajkovic and Luthans, 1998), and the central importance of entrepreneurial self-efficacy in theory and practice. Theoretical models of entrepreneurial intention (e.g., Krueger, 1993; Krueger et al., 2000; Shapero and Sokol, 1982; Zhao et al., 2005) consistently consider self-efficacy to be a key element in the perception of the feasibility of entrepreneurship, while empirical work has shown the value of self-efficacy for predicting successful company practice among both entrepreneurs and managers (Chen et al., 1998) and entrepreneurial women in traditional and non-traditional sectors (Anna et al., 2000). The discussion then maps characteristics of work placements to the theory-based predictors of self-efficacy in Social Cognitive Theory to establish which characteristics of undergraduate work experience would be expected to predict higher levels of venturing and technology self-efficacy.

The results section then describes a study that included more than four hundred UK engineering undergraduates who had previous work placements when they were surveyed in Autumn 2004. The measures of venturing and technology self-efficacy are presented, along with the questions that characterised different elements of their work experiences, including their company orientations, the nature and difficulty of their assigned work and the presence of role models where they were placed. The results of the analysis of this survey data lead to the conclusion that work experience on average had little effect on student self-efficacy, but that when their experience had the qualities generally known to predict enhanced self-efficacy, strong differences were found. The concluding discussion addresses the fact that while a work placement can have a major effect on self-efficacy, a foundation of future innovative behaviours, those factors are all too often not present in the work placements made in the UK.

2. Changes in the environments of education and work

There is growing recognition that opportunities for individuals to have life-long careers in a single large firm are declining. Technological and economic changes are leading to a world of work where individuals will have a greater variety of careers and employers as portfolio careers become common (Henderson and Robertson, 2000). This means that for many if not most people the future of work lies in small- and medium-sized enterprises that often lack the resources of large companies for training new employees, leaving open the question of where young professionals will be trained. Thus, at the same time as this source of training is declining, the need for transferable skills and hands-on experience is growing rapidly. A major task for higher education is the development of employees who not only have the right skills and attitudes but also the ability to learn from experience and adapt within a dynamic and rapidly changing environment.

The UK government has responded with initiatives intended to bring universities into the mainstream of enterprise education and skills development. Because of the importance of new technologies in opening new sectors of growth, there is also a growing trend, in part driven and supported by programmes such as Science Enterprise Challenge, for universities to offer both curriculum (education/degree-focussed) and non-curriculum-based (focussed on enterprise) activities to undergraduate and postgraduate students in SET (Galloway and Brown, 2002; Kirby, 2006). Knowledge and understanding of innovation and enterprise are important in helping to increase student awareness of and ability to capitalise upon opportunities in dynamic, high-technology sectors. Degree-based activities targeted at developing student knowledge and understanding of and skills/attitudes for innovation and enterprise include business and enterprise modules, in-class use of industry-based examples, video profiles of entrepreneurs (Robertson and Collins, 2003), lectures by guest speakers from industry, industry-sponsored projects and company-based placements (Cooper et al., 2004). Outside the classroom many institutions have student enterprise societies/networks and run intramural, or support student participation in extramural, business plan competitions (McGowan and Cooper, 2008).

Yet most individuals involved in the preparation of young professionals would agree that there are no substitutes for real work experience. To support and extend the effectiveness of