# 教育部教學實踐研究計畫成果報告

# Project Report for MOE Teaching Practice Research Program

計畫編號/Project Number： PSL1080099

學門專案分類/Division：社會(含法政)

執行期間/Funding Period：2019/08/01～2020/07/31

## 立基於技術、創新與企業家精神架構之計畫導向學習

## Project-Based Learning in Technology, Innovation and Entrepreneurship Framework

配合課程：

- 【108】跨領域創新 Cross-disciplined Innovation，合授教師：蔡德明教授、紀俊麟醫師
- 【108】興業家精神與全球企業競賽 Entrepreneurship and Global Business Competition，合授教師：黃仕斌教授

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成果報告公開日期：

□立即公開 ■延後公開(統一於 2022 年 9 月 30 日公開)

繳交報告日期(Report Submission Date)：

2020 年 8 月 24 日

# 立基於技術、創新與企業家精神架構之計畫導向學習

## 一. 報告內文(Content)(至少 3 頁)

### 1. 研究動機與目的(Research Motive and Purpose)

全球創業精神指標排名中，臺灣位居亞洲第一名、全世界第八名（根據美國「Global Entrepreneurship and Development Institute (GEI)」2015 排名），42%的臺灣人覺察到市場有創業機會，更有高達 72.9%臺灣人將創業視為職涯選擇（根據「全球創業觀察（Global Entrepreneurship Monitor, GEM）」2013 年度報告）但是，臺灣人害怕創業失敗的比例卻達 40.6%，且只有 27.2%的人認為自己有能力創業。

我國曾經是創造經濟奇蹟的亞洲四小龍之一，而今卻深陷紅色供應鏈、日、韓、東南亞諸國等之強力競爭，近十多年來面臨的薪資停滯、少子化、經濟產業發展停滯等種種挑戰，如何運用台灣青年創新創意創業之優勢，解決種種嚴峻的問題，實為當前的重要課題。 近期蔡政府亦提出「5+2」產業之創新政策，試圖開創具有在地特色、結合區域優勢，打造創新研發之產業群聚。申請者所在的國立交通大學位於新竹科學園區且提出 BioICT，來因應台灣高科技業近年來面臨「無以為繼」（unsustainable）的現況與瓶頸，及台灣高科技產業之產業升級轉型的課題，交大所提出啟動與開展台灣創新與創業家精神，將在亞洲矽谷扮演關鍵的重要地位。在台北交通大學分部將在國家創新園區預計成立創新與創業 EMBA，將在國家創新園區扮演點火器的角色，並培育更多創新創業人才。

有鑑於台灣高科技產業「無以為繼」的困境與轉型的挑戰，政府提出許多振興方案：BioICT 試圖在台灣 ICT 產業的既有研發基礎與優勢上，建立起生醫產業的研發成果。BioICT 是生物科技與高科技的會合（BioICT: Where Biotech and High-tech Meet），也就是將台灣最引以為傲的電子資訊科技，與極具發展潛力的生物醫學科學結合，進而創造台灣下一個黃金 50 年，目標是帶領台灣生醫產業邁向新世代。

本計畫是為跨領域的教學研究，探討跨領域關鍵技術整合的能力，試圖解決我國在創新創業的過程中所需要補足的缺口，提出之課程重點科技是以 BioICT、生物科技與穿戴式裝置為主。本研究是為綜合科技領域、管理領域、經濟社會領域之跨領域研究。跨領域課程的目的，在教學過程中建立科技與管理的對話，科技團隊與管理團隊的合作，並由其中激發出創新的潛能與創業的企業家精神。

### 2. 文獻探討(Literature Review)

In this section, we provide a brief review of related literature on the topics of technology, innovation and entrepreneurship. The topics are discussed in the following perspectives: 1) Technology Entrepreneurship and Cross-disciplined Innovation; and 2) BioICT in Linking Related Industries.

#### 1) Technology Entrepreneurship and Cross-disciplined Innovation

Nowadays technology innovations have been paving the way for outstanding improvement in manifold industries, and our lives have been enhanced significantly. Technology entrepreneurship and cross-disciplined innovation are two important fields affecting business directly. Technology entrepreneurship is an investment in a project that assembles and deploys specialized individuals and heterogeneous assets that are intricately related to advances in scientific and technological knowledge for the purpose of creating and capturing value for a firm. (Bailetti, 2012) Cross-disciplined innovation is the combination of disciplines with the innovations of technology to find the right solution as a key competence, finding the right partners to create a short route to market.

(1) **Technology entrepreneurship as a risky business: Experiential learning and risk-taking attitudes in entrepreneurship education**

Some researchers have previously theorized that the mixed effects of entrepreneurship education on entrepreneurial intention could be the result of students developing more realistic understandings of the risks of entrepreneurship, as well as more objective assessments of their own skills in these areas, after being exposed to entrepreneurship courses (Oosterbeek et al., 2010). Other researchers have found variability in learner's post-course entrepreneurial intentions based on the orientation (theoretical or practical) of the entrepreneurship course (Piperopoulos and Dimov, 2015). This research moves beyond the bimodal classification of entrepreneurship courses along the theory/practice divide by evaluating the effects of three distinct courses with different goals but which integrate information and communication technologies as well as experiential learning opportunities to create a more realistic entrepreneurial experience for entrepreneurship students, with more realistic assessment of external risks and internal skills.

While entrepreneurial intention appears to be sensitive to students' realistic evaluations of entrepreneurship after completing an entrepreneurship course, their propensity to take risks positively impacted by entrepreneurship courses, suggesting that risk taking can be an alternative metric for assessing the efficacy of entrepreneurship courses. Although entrepreneurship is a risky business, educating students about these risks, by experiential learning and risk-taking attitudes in entrepreneurship education that prepares students to deal with them through learning opportunities enhanced with critical entrepreneurial technologies and experiences with real world start-up companies, may give students the increased confidence in both their technical and business skills. Then the entrepreneurial education will ultimately lead them to become successful future entrepreneurs. (Bandera, Collins and Passerini, 2018).

Chung and Hwang (2019) show that technology entrepreneurship and external relationships may not always promote technology transfer. The empirical results show that the degree of PRO-industry collaboration has a negative effect on PROs' spin-off creation and positive effects on PROs' technology license agreements and licensing income. Government support also improves PROs' technology license agreements and licensing income by alleviating information asymmetry between PROs and industry. PRO- industry collaboration on

PROs’ technology commercialization performance is the double-edged sword, which can explains the different mechanism behind how PRO-external organizations relationships and PROs’ technology entrepreneurship affects technology licensing performance and spin-off creation.

(2) **The utilization of information communication technology (ICT) promote entrepreneurship**

Barnett, Hu and Wang (2019) found that cell phone ownership and Internet use have positive impacts on entrepreneurship. After controlling for observables, cell phone users (Internet users) are 2.1% (6.2%) more likely to engage in entrepreneurship than people who do not use them. Applies to the dataset of China Family Panel Survey, considering that the average entrepreneurship rate for rural households is only 9.2%, the influence of cell phone ownership and Internet use is very large. The empirical evidence also suggests that social networking and information acquisition play mediating roles in the impact of ICT utilization on entrepreneurship. The evidence of a positive effect of ICT utilization on entrepreneurship provides a new justification for policies or reforms intended to promote entrepreneurship by investment in ICT infrastructure, such as broadband construction in rural regions.

The impact of technology entrepreneurship on different regions also requires space-time analysis. Regions with vibrant startup activity in the technology sector will likely continue to enjoy their advantages over time. It further reminds policy makers of the difficulties and challenges in growing high technology entrepreneurship in less technology-intensive regions. (Qian and Zhao, 2018).

(3) **Cross-disciplined innovation ‘envision’ cross-disciplinary collaboration**

In the context of the wide and varied calls for cross-disciplinary collaborative work, the critical importance of collaboration to the vibrant and integrative work of futures research, and the now voluminous literature that highlights the range of challenges, pitfalls and perils. Priaulx and Weinel (2018) focus on the critical role that greater insight into other fields might play in helping to enhance connections between researchers situated in different and perhaps distant domains, and the lack of detailed engagement with the question of what researchers need to know about other fields in order to collaborate effectively across different fields. At present, with limited observations of how knowledge deficits constitute a barrier to cross-disciplinary collaboration, the solution is vaguely located in aspirations for actors to ‘know more’ than they currently do about other fields, and that this greater knowledge somehow constitutes the gateway to interdisciplinary work and cross-disciplinary.

Liang, Zhou, Huang, Hu, Xu and Jin (2018) present the modeling of cross-disciplinary collaboration for potential field discovery and recommendation based on digital scholarly big data database. As scholarly big data emerges, tremendous research progress and achievements, usually articulated in published articles, are captured in a digital scholarly database. Cross-disciplinary research collaboration among experts in different fields will facilitate advanced research. These collaborations utilizing expertise and techniques from multiple domains, fields, and disciplines are ubiquitous in academia, which have been proven effective in generating innovative academic research and practical applications. Research has shown that research collaboration contributes greatly to scientific productivity. Collaboration recommendation technology has helped researchers to find more related collaborations. Scientific recommenders seek solutions to the problems of information overload which are omnipresent in scholarly big data in such matters as promoting author relations, and detecting relevant research papers, or articles, and venues. Co-authorship has traditionally been used to identify valuable collaborators in corresponding fields. A citation network of academic articles can build article recommendation systems within bibliographic databases.

(4) **Facilitating cross-disciplinary interactions to stimulate innovation:**

Suzanne and Levine (2019) designate the leaders of the high-profile nonprofit program, "Stand up to Cancer (SU2C)." The mission is to raise awareness and funds to increase the pace of groundbreaking research that can get new therapies to patients quickly, and a group at the Institute for Advanced Study in Princeton, New Jersey, a world-famous center for theoretical research in physics and mathematics, teamed up to propose a multidisciplinary meeting to explore novel approaches to cancer research. The collaborative efforts resulted in the Convergence Ideas Lab meeting and these Convergence Teams might provide guidance for others seeking to organize and facilitate cross-disciplinary interactions to stimulate innovation in 2015.

The Convergence Ideas Lab meeting is just the beginning of a new way to do science and to foster cooperation and collaboration among scientists for the benefit of patients with cancer. Optimally, the Convergence team approach will open up a new field of research that can deepen our understanding of disease origin, progression, diagnosis, prognosis, treatment, and outcome, also lower the costs to society of developing effective therapeutic treatments, and of enhancing quality of life and outcome for cancer patients. This approach should be replicable with similar effects in other fields of medical research, including infectious diseases. The multidisciplinary approach and research projects developed at the Convergence Ideas Lab meeting and that are now underway have the potential to improve the lives and outcomes of disease in patients, to lower the costs to society of developing effective therapeutic treatments, and to enhance the education and training of the next generation of cancer researchers.

### 2) BioICT in Linking Related Industries

BioICT is considered to be "where Biotech and High-tech meet." Taiwan Government started and sponsored a set of various BioICT applications to serve as integrative and interdisciplined projects of all government sponsored programs. We are aiming at that Taiwan has an ideal mix of entrepreneurs, technology, financing, and operational infrastructure, including the support of the chief scientist, according to Taiwan National Development Council.

Haeussler, Patzelt and Zahra (2012) proposes that high technology new firms have extensively used strategic alliances to gain access to knowledge, resources and capabilities. They indicate the degree of specialization of new firms' technological capabilities moderates the impact of strategic alliances on product development and identify direction of the moderating effect depends on the types of alliances. Lin, et al (2012) explores the role of inter-firm R&D alliances as a vital mechanism for creating new technological knowledge, based on the absorptive capacity perspective. Specifically, three indicators of technology strategy are explored to examine the absorptive capacity, including proportion of R&D alliances in an alliance portfolio, technological distance, and R&D intensity, and their impacts on innovation performance.

Taken together, the importance of collaborative strategies is demonstrated in various studies. These studies investigate the extent to which different alliance types lead to improvement in firm's performance outcomes (e.g., Belderbos, Carree, and Lokshin, 2004; Köhler, Sofka, and Grimpe, 2012; Laursen and Salter, 2006; Salge, Farchi, Barrett, and Dopson, 2013). Cooperation with up-stream suppliers has been shown to help improve exploitation-related performance, such as input quality improvements, process innovations, and cost reductions (Sobrero and & Roberts, 2002). Collaboration with down-stream distributors can provide the focal firm with product and service feedback that could be used for product, process, and service improvements (Lee and Wong, 2009; Von Hippel, 2007). Alliance with competitors can provide the focal organization with access to industry-specific knowledge and could share research facilities (Kim and Higgins, 2007) and reducing research costs (Miotti and Sachwald, 2003). Strategic alliances with competitors could also be used to deal with industry standards and regulations (Nakamura, 2003). However, collaboration with competitors could have a downside due to an increased risk of outgoing unintended knowledge (Park and Russo, 1996).

Wilden, Gudergan, Nielsen, and Lings (2013) focused on dynamic capabilities in incorporating the processes that enable organizations to sustain superior performance over time. They argue theoretically and demonstrate empirically that these effects are contingent on organizational structure and the competitive intensity in the market. Zucker, Darby and Armstrong (2002) defined dynamic capabilities as knowledge capture and commercializing knowledge which involves transfer from discovering scientists to those who will develop it commercially. Halla and Bagchi-Sen (2002) considered R&D intensity and innovation measures are important factors for business performance in the Canadian biotechnology industry, which experienced rapid growth in the number of firms and revenues between 1994 and 1997.

The 21st century biotechnology cluster race has many regional entries in Taiwan and around the world. DeVol, et al (2004) stressed the importance of the biotechnology innovation park: "Because knowledge is generated, transmitted, and shared more efficiently in close proximity, economic activity based on new knowledge has a high propensity to cluster in a geographic area. A region with a top biotechnology cluster will have more innovations, less of which will escape to other regions, or at least, they will do so at a slower rate. Regions excel to the extent that the firms and talent in them can innovate successfully by being there, rather than elsewhere. This is particularly poignant for an industry such as biotechnology whose survival is based upon continuous innovation streams."

For the knowledge spillovers, there are considerable spillover effects when knowledge is created or employed in high technology industries (Jaffe, 1986, 1989), and perhaps also an important symbolic and legitimating function of high quality science for commercial activity (Stephan and Everhart 1998), Zucker, Darby and Armstrong (2002) in their empirical work identified the main and robust empirical effects due to real scientific labor contributions of star scientists to performance of the firm. Tsai (2005) identified the various types of knowledge spillovers of high-technology industries are alleged to be important determinants of' industrial clustering and finds substantive sectoral and spatial knowledge spillover effects, which are considered to be major motivating forces for regional concentration patterns of Taiwan's high-technology industries.

For the network with university or research institutes, ties that involve actual work at the science bench between star scientists (mostly academics) and firm scientists consistently have a significant positive effect on a wide range of firm performance measures in biotechnology (Zucker, Darby, and Armstrong 1998, Zucker and Darby 2001) and in semiconductors for number and quality of patents (Torero 1998). Ties to stars scientists also shorten the time for startup firms to IPO (firms are younger) and increase the amount of IPO proceeds (Darby et al., 2001).

The importance of intellectual human capital of basic university science to successful commercialization of important scientific discoveries are confirmed in Di Gregorio and Shane (2000). Zucker, Darby and Armstrong (2002) studied the economic value of knowledge at the time of commercially relevant scientific breakthroughs, and prove the real effects on the performance of biotech firms in comparing two overlapping groups of academic scientists who collaborate with firm scientists. However, Thursby and Thursby (2000) found that the sharp increase in university-industry technology transfer has not resulted so much from a shift in the nature of faculty research to license and increased interest on the part of firms

In terms of the quality of academic research, as expected scientific returns increase - measured by citations to other local star scientists working with firms - the probability that the next star will begin working with a firm also increases (Zucker et al., 2001). Quality is also positively related to working with firms in Japan, but only number of articles predicts significantly with this smaller sample. (Zucker et al., 2000).

The quality and magnitude of biotech patent portfolio has strong implications on new products and firm innovative performance. Developing a portfolio of new products is necessary to gain early cash flows, external visibility and legitimacy, early market share, and increase the likelihood of survival (Schoonhoven, Eisenhardt, and Lymman 1990). In addition, recent research has shown that new product development improves a firm's ability to raise money through an initial public offering (Deeds, DeCarolis, and Coombs 1997). Lin et al (2012) includes co-patents as the performance measurement reflects specific alliance innovation due to the fact that all the inventors involved ought to make some contribution to the final invention to obtain a co-assigned patent.

The BioICT and emerging technologies will alter the biotechnology and pharmaceutical industries in terms of health monitoring, treatment therapies and many emerging technologies. Shah et al. (2009) proposed that the future of pharmaceutical development focus on 7 major topics, including target identification, system biology, bioengineering/materials science/nanotechnology, personalized medicine, traditional medicines, information technology and bioinformatics, and environmental concerns and pharmaceuticals. In approaching these topics, traditional biological technology is no longer powerful in dealing with these new subjects. The new domain technologies applied into pharmaceutical industry would be ultrafast computing, tissue engineering/stem cells, non-invasive imaging, on demand delivery/miniaturization of monitoring and delivery equipment, robotics, and enhanced and pervasive information technology for sharing knowledge (Shah et al., 2009).

The key feature in these new domain would be to link the pharmaceutical industry with inter-disciplinary other industries. "Open Innovation" would be a strategy in linking the inter-disciplinary related industries to approach the integrated purpose. Bianchi et al. (2011) reflected that pharmaceutical firms would use inbound open innovation (licensing-in, alliance, or purchase technical services) to obtain the required resources, and outbound open innovation by commercially exploiting the technologies and knowledge for entering into different industries. Gerde and Mahto (2004) established the framework of biological micro-electromechanical systems for pharmaceutical firms and other stakeholder to explain their inter-dependent relationships.

### 3. 研究問題(Research Question)

本計畫屬於「技術實作教學實踐研究專案計畫」，研究目的是意圖探究以下面向：

1. 以前瞻、精準的視野和堅實的專業為基礎，在學術研究及教學實踐上，持續地提出跨域創新的構想與做法。此課程將打破單一專業科目的學習方式，融合各種不同領域的學生與教師。
2. 透過 Project-Based Learning，提供理論批判、科技學習，與商業模式設計實踐得以融合的場域。本課程採取跨專業教師聯合教學，以合作行動研究法，建置創新課程設計、教學教法，透過實踐、教學歷程的反思與回饋，整合跨領域教學。
3. 從使用者這一端，學生的學習範疇大幅擴大，以培養學生跨域全人素養與實作能力，盼望在全球化的環境中，學生不但具備專業與跨域技能，且涵富系統性思考與領導的能力。
4. 從教學研究者這一端，除了藉由發展大數據及深度學習模式研究全球的市場變化，找出可以改變世界的商機；也能藉由指導學生團隊，把握商機發展關鍵技術之創新與創業。

### 4. 研究設計與方法 (Research Methodology)

The research design and methodology are developed based on the following sources:

(1) Entrepreneurship education:

Babson entrepreneurship education framework, and

Berkeley entrepreneurship education framework

(2) HEA Fellowship

- Focus on the development of effective teaching and learning practices
- Define the intended learning outcomes, then prepare teaching activities that can achieve the intended learning outcomes
- Evidence based teaching and learning: lectures, peer learning, project based learning, small group learning, flipped learning, case studies …
- Feedbacks and assessments: assessing effectiveness of teaching from the teacher as well as learning from students---written tests, assignments, projects, quizzes, instantaneous online assessment, online polls, presentations, face to face meetings, written feedbacks.
- Formative and summative assessments
- Giving feedbacks to students to improve learning from assessments: face to face meeting, written feedbacks …

## 5. 教學暨研究成果(Teaching and Research Outcomes)

### (1) 教學過程與成果

本計劃本系列課程是為綜合科技領域、管理領域、經濟社會領域之跨領域創新。學生在課程中學習並演練科技與管理的對話，科技團隊與管理團隊的合作，並由其中激發出創新的潛能與創業的企業家精神。

在 2019 年度執行兩門課：
【108】跨領域創新 Cross-disciplined Innovation，合授教師：蔡德明教授、紀俊麟醫師
【108】興業家精神與全球企業競賽 Entrepreneurship and Global Business Competition，合授教師：黃仕斌教授

### (2) 教師教學反思

- 本計劃期盼藉著本系列課程的創業團隊，開發出更多以台灣為發展基地，向世界發聲的科技創新與創業。
- 本計畫所提出的跨領域科技ー創新ー企業家精神的架構，將發展出更多不同構面的科技ー創新ー企業家精神的 BioICT 跨領域學程，
- 本計劃的核心團隊已有創新醫療器材，2019 年獲得第十六屆國家新創獎（THE 16th NATIONAL INNOVATION AWARD）學研新創傑出機構。

### (3) 學生學習回饋

學生在本系列課程中，得以

- 探討以 BioICT、生物科技與穿戴式裝置為主之創新與創業議題
- 了解創業家思維以及其如何因應新創事業所面臨之挑戰
- 認識創業家各種籌資管道，以及投資者對於新創事業之期許
- 建立個人的領導計畫，如何開發「創業家精神」啟發創新、創造動機與動力。
- 探討科技新創事業所面臨的法律及智財權議題

最後藉由參與國際競賽使修課之同學能結合理論與實務，而有較貼近於市場實作的學習經驗。本學年有六個創業團隊同時報名參與 2020 年國際創業競賽 SCG Bangkok Business Challenge @ Sasin School of Management（SCG Bangkok Business Challenge @ Sasin 2020, Asia’s Longest-Running Global Student Startup Competition, held on February 20-22, 2020 @ Sasin School of Management, Thailand）：

1. D’ hui Robotics
2. RECO RECO: An Revolutionary & Efficient Device for Record of Recovery
3. GSS: Golden Sixty Seconds
4. DOCTANCE: An Innovative, Portable Stroke Diagnosis Device
5. CMOS-based Air Quality Monitor and Gas Sensor
6. HER2.AI: She is Too Important

DOCTANCE 最後進入決賽，並奪得總決賽第三名，及 Rocky Pitch 冠軍。

### 6. 建議與省思(Recommendations and Reflections)

本計畫以創新教學方法，經由實作演練之訓練（Practice-Based Design Thinking, PBDT），有效協助學生，產生更符合邏輯的產生良好的創新創意，並且在課程中分組以貫徹計畫導向學習（Project-Based Learning），各分組選定重點科技之議題，預備學生團隊在期末時提案競賽，產生代表隊參與國際創業競賽，進而建立學生自信心，更願意勇於嘗試創新創業。經由本教學實踐之研究，能進一步落實此一教學方法，充分運用台灣青年創新創意之優勢，突破現實課程安排及學生之學習場所與時間運用之限制。在此跨領域的學習中，將工學院、商學院與各學院有志科技創新創業的同學藉由日常探討創新創意，研究專利撰寫之過程，訓練邏輯思考，不同領域學生互相融入、學習異業結盟，對於創新創意產品的智慧財產權維 護及行銷拓展等商品化實務，並有實質的助益。

創新創業的課程成果不易呈現，本計畫以組成學生代表隊參與國際創業競賽的結果呈現。除此之外有兩個創業團隊已在 Prototype 的雛形階段，一個是基於分享經濟模型的 Cohabitat，另一個是 IET 應用的 JABEZ。本計畫盼望未來能成立一站式窗口，藉此分享醫材創業的成功經驗與失敗經驗。也盼望能將創新創業的敢冒險、敢創新、不怕失敗的品格，傳承在我們的文化當中。

## 二. 參考文獻(References)


創業管理 (陳明惠審訂、王筱甯編譯、華泰文化出版)

MIC AISP 情報顧問服務 http://www.mic.iii.org.tw/aisp/

內政部統計處 http://www.moi.gov.tw/stat/index.aspx

STPI 科技產業資訊室 http://iknow.stpi.org.tw/Post/Read.aspx?PostID=3235

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## 三. 附件**(Appendix)**

與本研究計畫相關之研究成果資料，可補充於附件，如學生評量工具、訪談問題 等等。