高職教師採用教學部落格的關鍵成功因素

The Critical Success Factors for Vocational High School Teachers' Adoption of Teaching Blogs

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摘要

　　部落格應用在教育的議題逐漸受到注意，因此本研究目的在探討高職教師採用教學部落格的關鍵成功因素及這些因素的相對重要性。以 Jeyaraj、Rottman 與 Lacity（（2006））的個人-科技-組織-環境架構為主軸，從個人創新採用及知識分享的文獻，發展一個整合的架構來探討影響高職學校教師是否採用教學部落格的關鍵成功因素。研究架構包括個人特性、創新特性、學校特性和環境特性四個構面，及 14 個可能的關鍵成功因素。本研究採用問卷調查方式回收有效問卷 510 份，並以羅吉斯迴歸（（Logistic Regression））統計方法考驗各項研究假說。研究結果顯示編碼化辛勞、個人創新特質、認知易用、相容性、認知愉悅、學校支持與學校獎勵等 7 個因素是辨識教師是否採用教學部落格的重要指標。最後，本研究根據研究結果，提出理論與實務意涵及後續研究建議。

關鍵詞：教學部落格、資訊科技採用、高職教師

Abstract

　　As Web 2.0 technology applications, blogs are receiving attention as potential educational tools. The purpose of this study is to determine which factors can significantly influence whether a vocational high school teacher chooses to use a teaching blog, and the relative importance of these influences. Based on Jeyaraj, Rottman, & Lacity's （2006） individual – technology – organization – environment framework that incorporates relevant factors from two sources: from within individual IT adoption literature and from within blog research emphasizing knowledge sharing motivation. The present study develops an integrated model for vocational high school teachers' teaching blog adoption. The model includes the four dimensions of individual, innovation

technology, school, and environmental characteristics and fourteen factors. Furthermore, logistic regression analysis is used to test the hypotheses. Based on an analysis of 510 survey respondents, the results indicate that codification effort, perceived enjoyment, school incentives, personal innovativeness, compatibility, school support, and perceived ease of use are important discriminant factors in the adoption of teaching blogs. Finally, theoretical and practical implications from the findings are also provided.

Keywords: Teaching blog, Information technology adoption, Vocational high school teachers

壹、緒論

　　Web2.0 的發展，興起了許多社會網絡服務（Social network service, SNS），例如部落格（Blog）、網路相簿（Online photo album）、維基百科（Wikipedia）等科技。Web2.0 的服務讓使用者不再是網站的消費者，同時也是生產者，藉由自由開放的網路，讓智慧得以共享。部落格提供簡單的介面，令使用者能夠容易的維護或增加一些新的內容，因此部落格可視為是一種創新知識分享科技（Chai & Kim, 2010; Hall & Davison, 2007）。部落格網站通常會有固定的格式，只要建立起部落格程式，或是找到一個提供部落格技術的網站，就可以透過簡單的介面來記錄文字，其操作介面人性化，且可快速發佈文章（Cowan, 2008）。

　　然而，強調互動、分享與娛樂的部落格及影片，已成為新的趨勢（李鴻亮、沈俊行，2012）。在教育方面，教師應用資訊科技輔助教學工作，是必然的趨勢。近年來，許多教師開始透過建立教學性質的部落格提供學生課程相關知識、教學檔案的下載，以改進其教學績效（Churchill, 2009; Farmer & Bartlett-Bragg, 2005），增進與其他老師或學生之間的知識分享（Kim, 2008）。因此本研究定義教學部落格為教師在個人所建立的部落格內，提供及分享自己在專業和教學上的想法及其他有關課程與教學方面的知識，並包括課程討論平台化與教學檔案的下載，使學生在課後能運用相關電子教學資源強化自我學習或透過部落格繼續與老師討論，促進學生自身及彼此間的學習表現（蔡元隆、侯相如，2007）。然而教學部落格的建立雖對教師教學上有所幫助，但並非每一位教師都毫無顧忌的接受及使用教學部落格所帶來教學上的益處，這意味著教師是否採用教學部落格尚有其他方面的考量，導致並非每一位教師都願意去建立個人的教學部落格，例如：教師也可能懼怕使用部落格的技術，因其分享教學的理念、知識及評論將使其他人在知識上會有所獲益，導致其感到本身有喪失知識的獨特優勢之感（Bock, Sabherwal, & Qian, 2008），在分享知識之後，必須回答伴隨而來的問題（Churchill, 2009; Kankanhalli, Tan, & Wei, 2005）。

　　部落格技術漸漸受到教師的注意，但也由於它的概念新穎使得教師在使用上會有一些考量，依第一屆教育部落格的教學採行部落格比例，高職教師僅佔有 5.71%[1]，是所有學校種類採用比例最低。因此，本研究欲探討影響高職學校教師採用部落格的關鍵因素，以提供高職學校在推行教學部落格的參考。

　　Jeyaraj、Rottman 與 Lacity（2006）針對 1992 年至 2003 年個人及組織科技採用之相關研究共計 99 篇進行分析，將 135 自變項歸納四大類特性，個人特性（Individual Characteristics）、創新特性（Innovation Characteristics）、組織特性（Organizational

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[1] 教學部落格的採行比例，幼稚園 2.56%，國小 60.43%，國中 16.73%，高中 14.57%，高職 5.71%

Characteristics）及環境特性（Environmental Characteristics）。在他們的研究中指出，個人特性、創新特性和組織特性是影響個人採用創新科技的因素。不過，環境特性尚未在個人科技採用被探討，但環境特性中，例如外部壓力（External Pressure）和同儕影響（Peer Influence）因素和個人採用資訊科技的決定卻是非常有關連性（Jeyaraj et al., 2006: 10）。因此本研究以Jeyaraj 等人的個人-創新-組織-環境架構為基礎，從個人特性、創新特性、學校特性和環境特性來瞭解高職學校教師採用教學部落格的關鍵因素，研究結果對於高職學校在推行教師採用教學部落格時有所幫助，以提出更合適的推行策略來促進教師採用。

貳、文獻探討與研究假說推演

一、教學部落格的興起與現況

　　關於部落格的發展，研究指出第一個部落格網站起源於 T. Berners-Lee 於 1991 年做的第一個部落格，目前的部落格形式實際出現於 1996 年，直到 1997 年，「Weblog」這個名詞才被用來稱呼這種新的溝通型態，指稱一種用網頁來呈現的個人日誌，到了 1999 年，P. Merholz 開始把「Weblog」唸成「We blog」，從此 Blog 成為一個新的名詞（Herring, Scheidt, Bonus, & Wright, 2004）。對個人來說，部落格是個人的讀者文摘，是一個網路日記加上超連結的模式，它比電子郵件、群體討論、BBS 更簡單和容易溝通，因為部落格易於發表與評論，以及內容可供訂閱的功能，使得部落格易於進行即時的互動（Pollard, 2005）。因此部落格在家庭、公司、部門或團隊中成為一個愈來愈受歡迎的交流工具。

　　部落格在教育方面也逐漸受到注意（Gong & Yan, 2008），國內外有關部落格與教學的研究在近年來逐漸增加。國內研究指出教學部落格有助於教師與學生彼此之間建立起一種教學回饋機制，亦可促進學生彼此合作學習的表現（王小蕙，2007; 林湘玲，2008）。教學部落格亦是教師多元評量的展現、自我教學歷程及學生學習歷程的紀錄（蔡元隆、侯相如，2007）。另外，亦有研究顯示教學部落格有助於學生的課後學習，強調教學部落格所提供給學生的討論平台及教師對學生於部落格所提出問題的回答會強化學生課後自我的知識學習（侯相如、王郁青，2008），林凱胤、王國華與蔡維真（2005）認為部落格能容易建立日誌分享與日誌迴響，容易與同儕經驗分享，因此是一個適合實習教師進行教學反思與經驗分享的平台。在國外的研究部份，Deng 和 Yuen（2010）研究部落格應用在師範教育上，指出部落格可以做為一個自我表現（Expressive）、反思（Reflective）和合作（Collaboration）的工具。Kim（2008）認為部落格能克服電腦中介傳播（Computer Mediated Communication, CMC）科技的限制，例如能改善師生或同儕之間的互動。Hall 和 Davison（2007） 探討部落格在圖書資訊科學教育者的使用。研究結果證實部落格有助於鼓勵教育者在教學教材上的反思及同儕間的互相支援。除此之外，部落格亦是一種班級經營的新模式，透過部落格的公佈功能可作為班級的聯絡簿、佈告欄、榮譽榜，而老師亦可發表關於學生生活的相關文章，營造出一個高度互動的知識社群（Brownstein & Klein, 2006）。

　　由於部落格有助於教師的教學成效（Churchill, 2009; Farmer & Bartlett-Bragg, 2005）與學生的自我學習（Churchill, 2009; Wang, Huang, Jeng, & Wang, 2008），加上隨著網際網路與資訊科技的發展，台灣教育部也一直在推動資訊科技融入教學，各學校為因應資訊科技的潮流與台灣教育部所制定的應用資訊科技發展方向，也開始極積鼓勵教師建置個人的教學部落格。

現今的部落格使用介面簡易，不需撰寫網頁（HTML）語法（Du & Wagner, 2006），教師透過學習簡單的資訊技術補足資訊能力的應用問題，便可輕鬆建置個人的教學部落格，使得在推行教師使用教學部落格上更為具有吸引力。

二、影響教學部落格採用之特性歸納

探討資訊科技的採用的研究，最早是 E. M. Rogers 於 1983 年提出創新擴散理論（Innovation Diffusion Theory, IDT），將創新（Innovation） 定義為一種被個人或是接受者認為是新的觀念或是行為、物件（Roger, 1983: 11）。而擴散（Diffusion）則被定義為一項創新，隨著時間的經過，透過特定管道，在社會系統群體間溝通的過程（Roger, 1983: 10）。Rogers 提出影響創新的知覺屬性包括五種特性，分別為相對優勢（Relative Advantage）、相容性（Compatibility）、複雜性（Complexity）、可試用性（Trialability）以及可觀察性（Observability）會影響資訊科技採用。且 Tanakinjal, Deans, 和 Gray（2010）也支持創新擴散理論在資訊創新擴散的重要性。而 Tornatzky 與 Fleischer（1990）指出影響組織創新科技的採行決策包含了三個重要因素，分別是組織特性、創新特性以及環境特性。Thong（1999）研究在中小企業資訊系統採用，提出一個整合模式，包含組織特性、創新特性、環境特性與高階主管（CEO characteristics）四項重要的影響構面。Jeyaraj 等人（2006）彙整過去 1992-2003 有關資訊科技採用的研究。提出四個構面應用在組織或個人的資訊科技採行。這四個構面包括創新特性、個人特性、組織特性和環境特性。而洪新原、張碩毅與郭吉原（2011）在組織對資訊科技的研究中，採用「組織特性」、「環境特性」、「資訊安全管理系統特性」三個構面，以及許麗玲、徐村和與吳憲政（2009）研究結果顯示「創新特性」對部落格有正向顯著影響。因此本研究以 Jeyaraj 等人的架構為基礎並綜合相關研究，歸納出影響高職教師採行教學部落格的關鍵因素，以個人特性、創新特性、學校特性和環境特性四個構面來探討。

（一）個人特性

1.編碼化辛勞（Codification Effort）

編碼化辛勞是指需要花費時間和辛勞以編寫知識到教師部落格（Markus, 2001）。在使用科技中花費的辛勞可被視為一種科技採用的預測指標（Agarwal, 2000）。當教師貢獻知識到教師部落格之後，可能會遇到接腫而來的問題，可能會額外花費到其他時間，並且還有可能要回應知識接收者額外的解說要求（Kankanhalli et al., 2005）。因此，本研究提出編碼化辛勞和教學部落格的採行有負向的關係。

[假說一]：編碼化辛勞會負向影響高職教師採用教學部落格

2.喪失知識優勢（Loss of Knowledge Power）

教師採用教學部落格後，在網站上貢獻他們獨一無二的知識，就可能喪失他們可以從這些知識所能獲得的利益。當個人的工作或角色在團體中出眾，是因為他們擁有獨特唯一的資訊，這代表他們的力量，而為了保留優勢，他們傾向不會分享，否則即有喪失知識優勢的可能性（Bock et al., 2008; Davenport & Prusak, 1998）。在許多知識分享的研究中指出，知識貢獻者可能會因為在貢獻知識之後，擔心當其它人取得知識後，會喪失自己的優勢或是價值（Ba et al., 2001; Davenport & Prusak, 1998）。當教師知覺採用教學部落格分享知識，會喪失其知識優勢，則傾向不會採用。因此，本研究提出喪失知識優勢和教學部落格的採行有負向的關係。

[假說二]：喪失知識優勢會負向影響高職教師採用教學部落格

3.聲譽（Reputation）

　　聲譽是指分享知識可以增加所獲得的正面形象，並使個人提升其在組織中的地位（Ba et al., 2001; Kankanhalli et al., 2005）。個人分享知識給予他人，能獲得較高的聲譽（Davenport & Prusak, 1998）。過去也有許多的研究指出，個人參與知識管理的活動，來自於個人聲譽的建立與促進（Donath, 1999; Wasko & Faraj, 2005）。個人會因為期望別人認同自己是個專家而願意去分享他們所擁有的最好的實務經驗（O'Dell & Grayson, 1998）。教師因透過教學部落格分享知識所能獲得的聲譽，將吸引教師建構教學部落格。因此，本研究提出聲譽和教學部落格的採行有正向的關係。

　　[假說三]：聲譽會正向影響高職教師採用教學部落格

4.利他主義（Altruism）

　　利他主義是指當人們在沒有任何報酬下，受到內心的愉悅而願意去幫助他人（Smith, 1981）。有些人願意付出善意而不期待回饋，這種行為稱之為利他（Fehr & Gachter, 2000），此種人會因為提供幫助而相對的獲得快樂（Kollock, 1999）。Davenport 與 Prusak（1998: 33-34）指出，「有人是天生的大好人，樂於與他人分享知識，除了一聲謝謝，並無多求。因為對所擁有的知識具有極高的熱情，因此樂於與人分享。這樣的人多少是受到本身對其專業的狂熱以及利他主義的驅使」。具有利他主義的教師會促使教師願意採用教學部落格，將知識分享予他人。因此，本研究提出利他主義和教學部落格的採行有正向的關係。

　　[假說四]：利他主義會正向影響高職教師採用教學部落格

5.知識自我效能（Knowledge Self-efficacy）

　　自我效能是指一個人能判斷自身所具有的能力，其可執行的行為範疇（Bandura, 1986），如果個人具有較高的自我效能，則會趨向於認同自己所擁有的知識，以幫助其他人解決問題（Kankanhalli et al., 2005）。知識貢獻者會因為其本身的知識自我效能高低進而影響分享自己專業的知識（Hsu, Ju, Yen, & Chang, 2007）。若個人對於知識具有自我效能感，認為自己提供的知識將會對他人產生影響或改變，將會樂於提供自己的經驗和知識給予其他人（Cabrera & Cabrera, 2005）。因此當教師知覺有較高的知識自我效能，會正向影響教師採用教學部落格的意願。因此，本研究提出知識自我效能和教學部落格的採行有正向的關係。

　　[假說五]：知識自我效能會正向影響高職教師採用教學部落格

6.個人創新特質（Personal Innovativeness）

　　個人創新是指個人對創新事物的接受程度（Rogers, 1983）。有較高創新的人會主動尋找新的想法，因此在面對高度的不確定性時，有較高的接受意圖（Lu, Liu, Yu, & Wang, 2008）。當同時有兩個人需要創新時，較具有個人創新的人在面對不確定的利益時，較願意去採用創新科技。因此個人創新是解釋個人願意採用一種新的資訊科技的重要關鍵因素（Agarwal & Prasad, 1998）。具有較高個人創新特質的教師，將會促使教師更願意去採用教學部落格。因此，本研究提出個人創新特質和教學部落格的採行有正向的關係。

　　[假說六]：個人創新特質會正向影響高職教師採用教學部落格

（二）創新特性

1.認知有用（Perceived Usefulness）

　　在 Davis、Bagozzi 與 Warshaw（1989）的資訊科技接受模式（Technology Acceptance Model, TAM），指出使用者接受新科技來自於對新科技的認知有用性與認知易用性。認知有用性定義為個人相信使用特定系統可以加強他們的工作績效的程度（Davis, 1989: 320）。當教師認知到教學部落格確實有助於其教學的績效（Churchill, 2009; Farmer & Bartlett-Bragg, 2005）及提高學生的學習成效，將促使教師提高採用教學部落格的意願。因此，本研究提出認知有用和教學部落格的採行有正向的關係。

　　[假說七]：認知有用會正向影響高職教師採用教學部落格

2.認知易用（Perceived Ease of Use）

　　Davis（1989: 320）定義認知易用為個人相信特定系統的使用，不需付出額外，而是使用較少的成本與時間，來使用資訊系統支援工作。當使用者已經發現系統很難使用或困難學習，使用者將會拒絕使用（Malhotra & Galletta, 2004; Viswanath Venkatesh, 1999）。因此認知易用性會增進使用者資訊科技的使用意圖（Davis, 1989; Davis et al., 1989）。當教師認知到教學部落格的使用及知識分享的容易性，將促使教師提高採用教學部落格的意願。因此，本研究提出認知易用和教學部落格的採行有正向的關係。

　　[假說八]：認知易用會正向影響高職教師採用教學部落格

3.相容性（Compatibility）

　　相容性是指創新科技與個人價值觀、過去經驗及現有需求相符的程度（Rogers, 1983: 224）。對於新科技來說，若過去的經驗與目前的價值系統符合的話，使用者會更願意使用新科技（Moore & Benbasat, 1991）。過去研究證實對創新科技的知覺相容性會正向影響創新科技的採用（Cooper & Zmud, 1990; Tan & Teo, 2000）。當教師知覺到教學部落格與過去的習慣和需求相容，將促進教師採用教學部落格。因此，本研究提出相容性和教學部落格的採行有正向的關係。

　　[假說九]：相容性會正向影響高職教師採用教學部落格

4.認知愉悅（Perceived Enjoyment）

　　認知愉悅定義為使用資訊科技所感到的愉快程度（Davis, Bagozzi, & Warshaw, 1992: 1113）。認知愉悅性被視為需要整合到原始科技接受模式的重要變數（Davis et al., 1992）。Davis 等人指出認知愉悅是一種內在動機，會影響個人對特定資訊系統的接受度，也就是說使用特定系統所感受到的娛樂性與本身的滿足，會引發使用者對資訊系統的採用意圖。研究也證實認知愉悅性對於資訊系統的使用意圖有顯著地影響（Heijden, 2004）。Hsu 與 Lin（2008） 指出使用者接受部落格的科技因素，包括認知易用和認知愉悅。具有較高的愉悅性會趨使使用者願意付出更多的時間和心力，並促進資訊科技的採用（Venkatesh, 2000）。因此，本研究提出認知愉悅和教學部落格的採行有正向的關係。

　　[假說十]：認知愉悅會正向影響高職教師採用教學部落格

（三）學校特性

1.學校支持（School Support）

　　過去研究大部份是在組織或個人採用某種創新資訊科技，很少是探討個人在學校的情境中採用某種創新資訊科技。因此本研究參考 Venkatesh 與 Bala（2008: 296）對組織管理支持（Management Support）的定義，將學校支持定義為個人相信學校會承諾支持在成功部落格的推行。在組織中，管理單位能間接或直接的介入資訊科技實行的過程，例如提供資源、指導使用或強制使用等（Jasperson, Carter, & Zmud, 2005）。在科技實行過程中，上級管理單位的支持是絕對關鍵的因素，上級管理單位的承諾支持和在實行過程中的溝通，有助於員工採用資訊科技（Venkatesh & Bala, 2008）。在學校中，學校上級管理單位的支持可視為重要的影響因素，有助於教學部落格的推廣。因此，本研究提出學校支持和教學部落格的採行有正向的關係。

　　[假說十一]：學校支持會正向影響高職教師採用教學部落格

2.學校獎勵（School Incentives）

　　獎勵措施是普遍企業界最常用來鼓勵員工的方式之一，例如紅利、升遷及獎金（Ba et al., 2001）。在組織中，提供外在的獎勵能促進有效的知識分享行為（Davenport & Prusak, 1998; Kankanhalli et al., 2005）。Kelman（1958）指出外在的報酬（Extrinsic Rewards） 能使員工獲得暫時的服從。因此學校在推廣教學部落格的同時，若能提出獎勵做為誘因，將能提昇教師採用教學部落格的意願。因此，本研究提出學校獎勵和教學部落格的採行有正向的關係。

　　[假說十二]：學校獎勵會正向影響高職教師採用教學部落格

（四）環境特性

1.主管影響（Superior Influence）

　　外部壓力和同儕影響是個人決定採用資訊科技的重要預測變數（Jeyaraj et al., 2006）。因為個人所處的社會環境中的其他人的想法和意見，會影響一個人的採行決策（Burt, 1997）。Taylor 與 Todd（1995）提出分解式計劃行為理論（Decomposed Theory of Planned Behavior, DTPB），將主觀規範解構為同儕影響和主管影響兩項變數。Bhattacherjee（2000） 則將主觀規範解構為外部的影響和人際的影響（Interpersonal Influence）。其中人際的影響包含同儕影響和主管影響，指經由朋友、上司、同學和其他已經採用創新者對於該創新的評價所造成的影響（Bhattacherjee, 2000）。本研究的主管影響是指教師所屬科系單位主管的影響，若單位主管已經採行部落格或主管的意見促使採用，則能提昇教師的採用意圖。因此，本研究提出主管影響和教學部落格的採行有正向的關係。

　　[假說十三]：主管影響會正向影響高職教師採用教學部落格

2.同儕影響（Peer Influence）

　　同儕影響是指使用者者身邊中，對使用者重要且對於使用者的想法能夠產生影響的人，例如朋友、同事、兄弟姊妹等人。自古以來，人們就很容易受到同儕影響，有樣學樣；進入了網路時代，資訊的傳遞快速，這種現象就更明顯了。Taylor 與 Todd（1995）認為在組織中，每個參考群體對使用者是否使用資訊科技有著不同的觀點，因此將主觀規範解構為主管影響及同儕影響。葉美春與阮明淑（2007）指出在推行知識管理系統時，應以同事間互相討論鼓勵，以達宣導系統使用的目的。過去的研究也指出同儕影響是決定一個人是否要採用無線通訊服務的因素之一（Hung, Ku, & Chang, 2003）。甚至教師認為教學檔案部落格為一容易維護的平台，且願意將部落格推廣至其同儕（楊慈儀，2011）。因此，本研究提出同儕影響和教學部落格的採行有正向的關係。

　　[假說十四]：同儕影響會正向影響高職教師採用教學部落格

參、研究方法

一、研究對象

　　本研究的抽樣母體為教育部公佈的 96 學年度（2007-2008）的高職學校名冊統計資料[2]，以地理位置區分，如表 1 所示。故本研究之研究對象是以台灣本島 154 所高職學校為研究對象。

表 1 以地理位置區分的高職學校數

城鎮	學校數量	城鎮	學校數量	城鎮	學校數量	城鎮	學校數量
宜蘭縣	5	苗栗縣	7	嘉義市	6	台東縣	4
基隆市	4	台中市	4	嘉義縣	4	花蓮縣	6
台北市	17	台中縣	5	台南市	5		
台北縣	16	彰化縣	11	台南縣	11		
桃園縣	7	南投縣	6	高雄市	10		
新竹市	2	雲林縣	7	高雄縣	8		
新竹縣	1			屏東縣	8		
合計	52	合計	40	合計	52	合計	10

　　本研究的抽樣方式採用分層隨機抽樣法（Stratified Random Sampling），在每一層中依照各層母體人數比例隨機選取樣本。本研究將學校分為北中南東四群，分別為每一間學校編碼，再以電腦的隨機程式選出被抽中的學校。本研究的問卷發放採用郵寄問卷發放，經由聯絡學校的學務處協助問卷發放，如果不同意協助問卷發放的學校，則再由電腦程式隨機產生一批新的補充樣本。第一次問卷發放北部 4 所、中部 3 所及南部 3 所高職學校，各 20 份問卷，總計 200 份問卷。第二次問卷發放北部 11 所，中部 9 所，南部 12 所及東部 3 所高職學校，各

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20 份問卷，總計 700 份問卷。兩次的問卷發放之後，北、中、南、東的樣本比例為 5:4:5:1，接近母體比例。

二、問卷設計

　　本研究係以問卷作為實證研究資料蒐集的工具，問卷採用結構化問卷設計，以利後續的資料統計與量化。衡量的方法採用李克特量表的五等第評量尺度（Five-point Likert scale） 設計，受測者根據自己認知的重要程度，針對非常不同意、有點不同意、普通、有點同意、非常同意作回答。問卷分成兩大部分，第一部分為基本資料，包括填答者基本資料與採用教學部落格現況等資料；第二部份為影響教師採行教學部落格之考慮因素，分別有個人特性、創新特性、學校特性與環境特性。問卷設計是參考國外相關研究的問卷設計方式，並將每一量表翻成中文，中文語法及語意盡量不破壞原始英文意涵，並且修飾成為一般較淺顯易懂的問項，以提升受測者理解上的容易度。本研究之編碼化辛勞、喪失知識優勢、聲譽、利他主義與知識自我效能採用 Kankanhalli 等人（2005）的研究；個人創新特質則採用於 Agarwal 與 Prasad（1998）的研究；認知有用性、認知易用性、學校支持、主管影響及同儕影響則採用於 Lewis、Agarwal 和 Sambamurthy（2003）的研究；認知愉悅性採用自 Venkatesh（2000）的研究；相容性和學校獎勵則依照變數的定義自編量表。在問卷完稿之後，進行問卷的前測與預試，前測的部份邀請 5 位領域專家及博士班學生進行語意及詞句上的修改；預試的部份則邀請已經採用教學部落格的教師，共計 120 人完成預試，完成之後，進行資料的信度與效度分析，針對問卷內容再進行修正，以提高本研究問卷的內容效度。

肆、資料分析與結果討論

一、樣本人口資料基本特性

　　第一次問卷發放 10 間學校，每校發出 20 份問卷，共計 200 份，回收 112 份，有效 108 份（北部 52 份，中部 25 份，南部 31 份）。第二次問卷發放 35 間學校，每校發出 20 份問卷，共計 700 份，回收 424 份，有效 402 份（北部 140 份，中部 98 份，南部 125 份，東部 39 份）。兩次有效問卷數合計為 510 份（北部 192 份，中部 123 份，南部 156 份，東部 39 份）。第一次問卷與第二次問卷，使用 t 檢定來檢驗兩次回收問卷在各研究變項是否有顯著差異，結果顯示各研究變項在 0.05 的顯著水準下，兩次回收問卷並無顯著的差異存在，如表 2 所示。

　　針對上述 45 間學校所回收的問卷，進行描述樣本之基本結構，如表 3 所示。而就教師是否採用教學部落格之樣本分布，其中採用一段時間有 104 人；剛採用有 107 人；計劃採用為 172 人；無計劃採用為 127 人。而本研究以教師是否已實際採用教學部落格為劃分點，將樣本區分為採用及未採用，因此採用部分包含採用一段時間及剛採用，合計共 211 人，占有效樣本比例為 41.4%，而未採用部分則包括計劃採用及無計劃採用，合計共 299 人，其占有效樣本數的 58.6%。

表 2 兩次樣本之獨立卡方檢定

研究變項	χ^2 值	p-value
編碼化辛勞	0.914	0.339
喪失知識優勢	0.103	0.748
聲譽	1.003	0.317
利他主義	0.517	0.472
知識自我效能	0.097	0.755
個人創新特質	0.195	0.659
認知有用	0.120	0.729
認知易用	0.479	0.489
相容性	1.703	0.192
認知愉悅	0.889	0.346
學校支持	0.088	0.767
學校獎勵	0.521	0.470
主管影響	0.055	0.815
同儕影響	0.435	0.510

二、信度與效度分析

信度是指測量各構面的可靠程度，衡量內部一致性或穩定性的程度。本研究採用 Cronbach's Alpha 係數檢定信度，結果如表 4 所示。Hair、Black、Babin、Anderson 與 Tatham 等人（2006: 102）指出 Cronbach's Alpha 值一般的最低可接受值為 0.6 至 0.7 之間，結果係數從 0.739 到 0.922，滿足大於 0.7 的標準，表示本研究具有良好的信度水準與內部一致性。本研究檢測內容效度（Content Validity）與建構效度（Construct Validity）。內容效度是指問卷內容具有代表性。本研究問卷參考國內外文獻加以修訂，且與學術或實務專家討論過，輔以前測與預試的進行，即可被視為具有相當的內容效度。建構效度方面則衡量收斂效度（Convergent Validity）與區別效度（Discriminant Validity）。收斂效度是衡量每個構面的收斂程度，即相關的因素是否會歸於相同構面的程度；而區別效度是指在其他構面的因素，因素負荷量是否低於 0.5。本研究採用因素分析衡量建構效度。本研究分別針對個人特性、創新特性、組織特性與環境特性進行因素分析。採用因素分析的主成份分析法，利用最大變異法對因素進行轉軸。因素負荷量選取原則為各因素之特徵值必須大於及因素負荷量至少大於 0.5（Hair et al., 2006: 120, 128）。個人特性方面，知識自我效能第 3 題及第 4 題因素負荷量小於 0.5，經過與專家討論後決定將之刪除。

表 3 樣本基本資料結構

資料項目	資料類別	樣本數	百分比
性別	女	233	45.7%
	男	277	54.3%
年齡	21～25 歲	7	1.4%
	26～30 歲	133	26.1%
	31～35 歲	126	24.7%
	36～40 歲	113	22.2%
	41～45 歲	71	13.9%
	46～50 歲	39	7.6%
	51 歲以上	21	4.1%
教育程度	師專	13	2.5%
	大學	227	44.5%
	研究所（含）以上	270	52.9%
學校屬性	公立	285	55.9%
	私立	225	44.1%
每週電腦使用總時數	8 小時（含）以下	87	17.1%
	9～16 小時	135	26.5%
	17～24 小時	120	23.5%
	25～32 小時	80	15.7%
	33 小時（含）以上	88	17.3%
是否採用教學部落格	採用一段時間（滿半年以上）	104	20.4%
	剛採用（未滿半年）	107	21.0%
	計劃採用	172	33.7%
	無計劃採用	127	24.9%

表 4 信度與效度分析

構面	研究變項	衡量項目	因素負荷量	主成份特徵值	解釋變異量（累積變異量）	Cronbach's Alpha
個人特性	編碼化辛勞	沒有時間發佈知識	0.803	4.868	16.335%（16.335%）	0.882
		編寫非常吃力	0.847			
		花費很多心力	0.825			
		花費額外時間回答問題	0.848			
		害怕須做額外的解說或協助	0.801			
	喪失知識優勢	降低在學校中獨特的價值	0.927	3.459	13.202%（29.537%）	0.918
		削弱教學權威	0.935			
		喪失唯獨吾有的專業知識	0.915			
	聲譽	分享知識可增進名譽	0.589	2.606	12.384%（41.921%）	0.752
		比沒有分享的教師較具聲望	0.797			
		有助於別人認識我	0.679			
		會贏得別人的尊敬	0.762			
	利他主義	樂於與他人分享教學相關知識	0.786	1.426	11.069%（52.989%）	0.841
		可以幫助學生或其他人	0.788			
		分享教學相關知識的感覺很好	0.802			
		分享教學相關知識，讓我感到愉快	0.762			
	知識自我效能	能提供有價值的教學相關知識	0.791	1.392	9.842%（62.832%）	0.739
		具提供教學相關知識的專業能力	0.810			
		別人一樣可以提供知識（反項）	NA			
		其他人提供的知識更有價值（反項）	NA			
	個人創新特質	比其他人更喜歡接受創新的想法	0.754	1.030	7.554%（70.386%）	0.767
		勇於嘗試新的方法	0.789			
		對新的資訊科技感到遲疑（反項）	0.831			
創新特性		更快完成教學工作	0.866	5.452	25.419%（25.419%）	0.922
		改進我的教學品質	0.859			
	認知有用	教學變得容易	0.867			
		增加教學成效	0.848			
		更能掌握教學進度	0.852			
	認知易用	支援教學是清楚且容易瞭解	0.821	2.679	19.818%（45.237%）	0.881
		容易使用軟體介面	0.862			
		使用教學部落格是容易的	0.851			

表 4 信度與效度分析（續）

構面	研究變項	衡量項目	因素負荷量	主成份特徵值	解釋變異量（累積變異量）	Cronbach's Alpha
創新特性	認知易用相容性	學習使用教學部落格是容易的	0.809	1.957	16.663%（61.900%）	0.847
		合乎教學習慣	0.824			
		輔助教學是有幫助的	0.843			
		符合我的需求	0.849			
	認知愉悅	使用教學部落格心情是愉快的	0.881	1.499	15.354%（77.254%）	0.899
		教學部落格的過程是令人愉快的	0.906			
		開心的使用教學部落格	0.878			
學校特性	學校支持	學校致力推行教學部落格	0.845	3.748	43.482%（43.482%）	0.891
		學校肯定在教學部落格的努力	0.835			
		學校鼓勵教師使用教學部落格	0.860			
		學校認同在教學部落格的努力	0.857			
		學校認同使用教學部落格	0.755			
	學校獎勵	提供獎勵機制會影響使用	0.899	2.123	29.910%（73.392%）	0.864
		納入考績考核會影響使用	0.884			
		公開場合適時表揚會影響使用	0.858			
環境特性	主管影響	單位主管認為使用是有價值的	0.887	3.039	39.455%（39.455%）	0.865
		單位主管的意見是重要的	0.884			
		單位主管已使用，將會督促我使用	0.859			
	同儕影響	同事認為使用是有價值的	0.824	1.614	38.096%（77.552%）	0.842
		同事的意見是重要的	0.892			
		同事大多使用將會督促使用	0.868			

三、研究假說關係之驗證

　　本研究以 SPSS 15 統計套裝軟體做為分析工具，並使用羅吉斯迴歸（Logistic Regression）進行資料分析。在羅吉斯迴歸模式的檢定中，-2 對數概似（-2 Log Likelihood）愈小且 Cox & Snell R^2 越大表示模式配適度越高（Hair et al., 2006: 361-362），而表 5 中之 Cox & Snell R^2 = 0.426 與 Nagelkerke R^2 = 0.574 均超過 R^2 = 0.15 之門檻設定值，顯示此模式具有顯著的解釋能力。在羅吉斯迴歸模式的整體模式檢定中，當 χ^2 值達到顯著，表示在投入的全部自變數中，至少有一個自變數能有效預測樣本在依變數的機率值。而 Hosmer-Lemeshow 檢定則是當其檢定值未達顯著水準時，表示整體模式的配適度佳（Hair et al., 2006: 372），研究結果顯示 p = 0.316（$p > 0.05$），未達顯著水準，因此模式有良好的配適度。Hair 等人建議對羅吉斯迴歸模式的整體配適度檢定，最好同時使用上述二種方法，以綜合判斷結果的意義。

表 5 羅吉斯迴歸模式摘要表

-2 對數概似	Cox & Snell R 平方	Nagelkerke R 平方
408.528	0.426	0.574

Hosmer 和 Lemeshow 檢定		
卡方值	自由度	顯著性
9.315	8	0.316

表 6 羅吉斯迴歸分析結果

變數名稱	係數 β	標準誤（S.E.）	Wald 統計量	自由度	顯著性	指數係數	假說支持?
編碼化辛勞（H1）	-.981	.153	41.040	1	.000	-.981	成立
喪失知識優勢（H2）	-.069	.112	.377	1	.539	-.069	不成立
聲譽（H3）	-.169	.199	.716	1	.397	-.169	不成立
利他主義（H4）	-.083	.169	.243	1	.622	-.083	不成立
知識自我效能（H5）	-.270	.165	2.670	1	.102	-.270	不成立
個人創新特質（H6）	.527	.163	10.492	1	.001	.527	成立
認知有用（H7）	.120	.124	.936	1	.333	.120	不成立
認知易用（H8）	.329	.138	5.683	1	.017	.329	成立
相容性（H9）	.463	.147	9.925	1	.002	.463	成立
認知愉悅（H10）	.820	.131	39.013	1	.000	.820	成立
學校支持（H11）	.332	.137	5.875	1	.015	.332	成立
學校獎勵（H12）	.628	.125	25.142	1	.000	.628	成立
主管影響（H13）	.030	.136	.050	1	.824	.030	不成立
同儕影響（H14）	-.082	.139	.345	1	.557	-.082	不成立
整體模式適配度檢定	模式係數的 omnibus 檢定 卡方值=283.221; 顯著性 0.000						
	Hosmer-Lemeshow 檢定 卡方值=9.315; 顯著性 0.316						

表 7 羅吉斯迴歸分析分類預測結果

	預測未採用		預測採用		總和
未採用	257	（86%）	42	（14%）	299
採用	51	（24.2%）	160	（75.8%）	211
分類預測正確率: 81.8%					

　　在表 7 分類結果中，可以發現原本未採用的人數有 299 人，經羅吉斯迴歸分類有 257 人被正確的分類，有 42 人被錯誤的分類，因此未採用的正確分類率為 86%。而已採用有 211 人，經分類有 160 人被正確的分類，有 51 人被錯誤的分類，因此有採用的正確分類率為 75.8%。羅吉斯迴歸的正確預測率為 81.8%。研究假說檢定結果顯示在全部 14 條假說中，共有 7 條假假說成立，7 條不成立。詳見表 6。這 7 個因素的相對重要性依序為：編碼化辛勞、認知愉悅、學校獎勵、個人創新特質、相容性、學校支持和認知易用。如圖 1 所示。
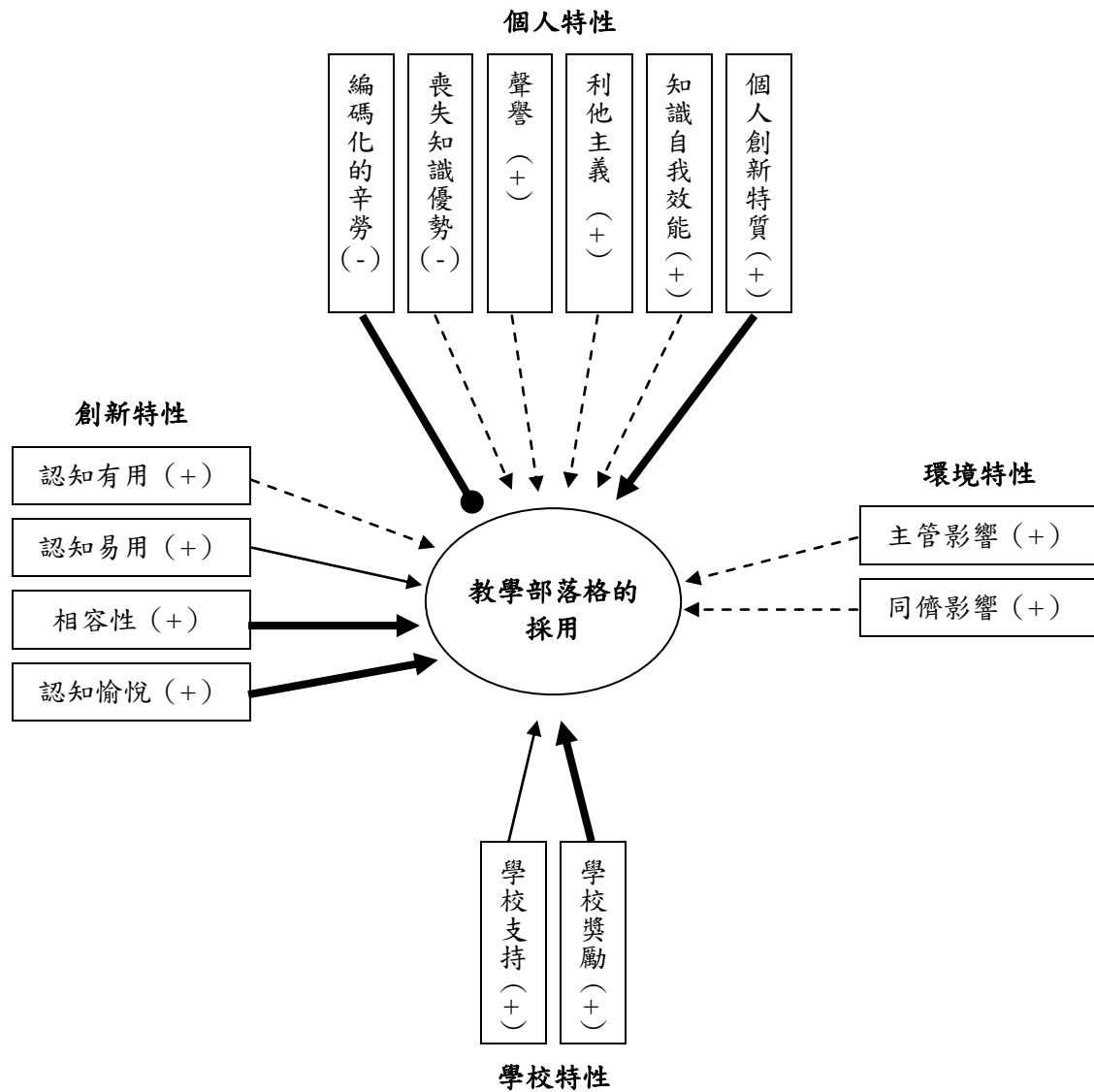
圖 1　研究結果

（一）編碼化辛勞

　　欲驗證編碼化辛勞是否會負向影響高職教師採用教學部落格，結果顯示編碼化辛勞是負向區辨性強的變數（$\beta = -0.981; p=0.000$），表示編碼化辛勞確實是一個影響高職教師是否採用教學部落格的重要因素。如過去研究指出，當教師知覺貢獻知識到部落格中需花費較多心力與時間，則會降低教師採用的意圖（Ba et al., 2001）。教師經營部落格必須保持在即時的狀態（Churchill, 2009），針對學生提出的問題也必須給予回饋，這會花費較多的時間和心力。結果顯示編碼化的辛勞是影響高職教師是否採行教學部落格的重要影響因素。

（二）喪失知識優勢

　　欲驗證喪失知識優勢是否會負向影響高職教師採用教學部落格；結果顯示在 0.05 顯著水準下，係數值為-0.069，p-value 為 0.539 未達顯著，與本研究的先前預期不同，表示高職教師在考慮是否採用教學部落格時，喪失知識優勢並非其主要考量。可能的原因是教學部落格屬於 Web 2.0 所涵蓋的科技之一，而 Web 2.0 的概念強調資訊的彼此分享（Drexler, Baralt, & Dawson, 2008），因此當高職教師採用教學部落格分享知識給予其他人的同時，亦能得到其他人的回饋。在這樣的環節下，教師除了在分享知識，也在接收知識，故不會有喪失知識優勢的感覺。

（三）聲譽

　　欲驗證聲譽是否會正向影響高職教師採用教學部落格；結果顯示在 0.05 顯著水準下，係數值為-0.169，p-value 為 0.397 未達顯著，與本研究預期不同，表示教師在考慮是否採用教學部落格時，聲譽並非其主要考量。可能的解釋是聲譽是指可以獲得正面形象的增加，並使個人提升其在組織中的地位（Ba et al., 2001; Kankanhalli et al., 2005），然而教師並非在同一所學校內，因此對於提昇個人的名聲沒有多大的利害關係，因此聲譽對於高職教師是否採用教師部落格的決策不會造成影響。

（四）利他主義

　　欲驗證利他主義是否會正向影響高職教師採用教學部落格；結果顯示在 0.05 顯著水準下，係數值為-0.083，p-value 為 0.622 未達顯著，表示利他主義不會影響高職教師是否採用教學部落格。教師是否樂於貢獻知識幫助別人，與教師採用教學部落格的原因無直接相關。本研究推論可能的原因為高職教師在面對學生的升學壓力下，因此無多餘的時間和精力。或者是因為在學校的利他文化不盛行，利他主義的風氣就會受到抑制（Davenport & Prusak, 1998: 34）。研究結果顯示利他主義對於高職教師是否採用教師部落格的決策不會造成影響。

（五）知識自我效能

　　欲驗證知識自我效能是否會正向影響高職教師採用教學部落格；結果顯示，在 0.05 顯著水準下，係數值為-0.270，p-value 為 0.102，結果未達顯著，表示高職教師對於知識具有自我效能感的高低，並不會直接影響採用教學部落格。知識自我效能是指知識貢獻者認為自身有能力貢獻具有一定品質知識的自我認知（Hsu et al., 2007），而這樣的認知對於教師而言，其本身職業就為知識的傳播者，其職業目的就在於傳授學生日後賴以生存的專業知識，因此不管是否採用教學部落格的教師，因其早已受過一定水準之教育訓練而成為合格教師，故其應

都具備較高的知識自我效能，所以知識自我效能對於高職教師是否採用教師部落格的決策不會造成影響。

（六）個人創新特質

　　欲驗證個人創新特質是否會正向影響高職教師採用教學部落格；結果顯示個人創新特質是一個正向區辨性強的變數（$\beta = 0.517; p=0.001$），表示教師的個人創新特質會正向影響高職教師採用教學部落格。個人創新特質較高，會願意拋棄舊有的做法而去嘗試新的做法，對於創新做法的接受度也較高（Lu et al., 2008），因此具有較高個人創新特質的教師對於教學部落格此一新興資訊科技的接受度會比尚未採用的教師來的高，因而有較高的意願去採用教學部落格。結果顯示個人創新特質是影響高職教師是否採行教學部落格的重要影響因素。

（七）認知有用

　　欲驗證認知有用是否會正向影響高職教師採用教學部落格；分析結果顯示在 0.05 顯著水準下，係數值為 0.120，p-value 為 0.333 未達顯著，和本研究的預期不同。高職教師對於教學部落格是否能提昇教學成效，並不會促使其採行教學部落格。本研究推論可能的原因如陳順孝（2004）指出部落格除了可以建立教學研究檔案與他人共享外、作為教學輔助媒體外，部落格也能作為對話園地，它能幫助教師、學生、家長三方建構教室以外的知識交流與對話的空間，因此提昇教學成效並非最重要的考量。研究結果顯示認知有用對於高職教師是否採用教師部落格的決策不會造成影響。

（八）認知易用

　　欲驗證認知易用是否會正向影響高職教師採用教學部落格；結果顯示認知易用是一個正向區辨性佳的變數（$\beta = 0.329; p=0.017$），表示高職教師知覺部落格的認知易用會正向影響教師採用教學部落格。過去已有大量的行為決策制定與資訊系統使用的研究，指出個人的行為在於企圖將努力最小化，所以支持了認知易用性與使用行為意圖之間的關係（Venkatesh, 2000）。教學部落格除了簡單的文字、圖片之外，可能還有其他型式的多媒體檔案需用來輔助教學（林凱胤、王國華、蔡維真，2005）。因此當教學部落格愈容易使用，愈容易發佈各種型式的教學媒體，對於使用者而言能花費較少的心力學習，將能促使高職教師採用教學部落格。結果顯示認知易用是影響高職教師是否採行教學部落格的重要影響因素。

（九）相容性

　　欲驗證相容性是否會正向影響高職教師採用教學部落格；結果顯示相容性是一個正向區辨性強的變數（$\beta = 0.463; p=0.002$），表示相容性是影響高職教師是否採用教學部落格的因素。Teng、Grover 與 Guttler 等人（2002）指出在探討創新特性於科技採用的研究中，相容性是最常被驗證有影響力與預測力的特性。本研究結果也證實高職教師在考量是否使用教學部落格時，會注重部落格是否合乎教學習慣和需求。當知覺相容性程度愈高，採用的可能性就愈高。結果顯示相容性是影響高職教師是否採行教學部落格的重要影響因素。

（十）認知愉悅

　　欲驗證認知愉悅是否會正向影響高職教師採用教學部落格；結果顯示認知愉悅是一個正向區辨性強的變數（$\beta = 0.820; p=0.000$），表示認知愉悅是影響高職教師是否採用教學部落格的因素。Hsu 與 Lin（2008）探討使用者對於部落格的接受，結果顯示認知愉悅是最重要的科技因素。在一個全球資訊網環境下，或是在一個輕鬆的環境中，使用者接受新資訊科技是因為能感受到愉悅的感覺（Heijden, 2004）。陳順孝（2004）指出部落格能夠讓人享受寫作、發表、對話、行動的樂趣。結果顯示認知愉悅是影響高職教師是否採行教學部落格的重要影響因素。

（十一）學校支持

　　欲驗證學校支持是否會正向影響高職教師採用教學部落格；結果顯示學校支持是一個正向區辨性佳的變數（$\beta = 0.332; p=0.015$），表示學校的支持確實有助於提升教師採用教學部落格之意願。在組織中，組織支持能降低使用者使用系統的焦慮（Venkatesh & Bala, 2008）。吳清山（2001）指出，為提升學校的效能，增強學校的知識管理，學校的支持是很重要的因素。過去研究也指出學校當局鼓勵教師使用網路學習系統，則教師的使用意圖也會增加（Franklin, 2007）。本研究的結果亦證實，已採用教學部落格的教師多半受到學校的支持，而尚未採用的教師則缺乏學校的支持，因此缺乏動力及有較低的採用意願。結果顯示學校支持是影響高職教師是否採行教學部落格的重要影響因素。

（十二）學校獎勵

　　欲驗證學校獎勵是否會正向影響高職教師採用教學部落格；結果顯示學校獎勵是一個正向區辨性強的變數（$\beta = 0.628; p=0.000$），表示當學校在推行教學部落格時，提供的獎勵機制與考核機制，對於高職教師採用教學部落格有顯著影響。過去的研究顯示要人們分享知識，那麼必須給予鼓勵及賦予酬勞（Davenport & Prusak, 1998）。報酬是影響員工願意使用知識管理系統的重要因素（Kankanhalli et al., 2005），因為有效的報酬能建立正向的使用態度（Hall, 2001）。結果顯示學校獎勵是影響高職教師是否採行教學部落格的重要影響因素。

（十三）主管影響

　　欲驗證主管影響是否會正向影響高職教師採用教學部落格；結果顯示在 0.05 顯著水準下，係數值為 0.030，p-value 為 0.824 未達顯著，表示高職教師不會因為主管的意見而影響其是否採用教學部落格的決定，此結果與本研究的先前假說不同。這表示主管這個參考群體對高職教師的採用無顯著影響。即使是主管認同教學部落格在教學上的價值及鼓吹教師採用教學部落格，其影響仍未能大到足以說服高職教師採用教學部落格。其可能的原因是學校具有雙重系統的特性，意即學校行政系統強調階層分明，教學系統的自主性高（黃哲彬，2002）。教師的主管指的是單位主任，主任亦是由教師來兼任單位主管，在學校體制中，主管對教師較無約束力，這和企業主管對下屬的約束力不同，使得學校主管僅能宣導、溝通方式進行，而未能高度影響教師提高其採用教學部落格的意願。研究結果顯示主管影響對於高職教師是否採用教師部落格的決策不會造成影響。

（十四）同儕影響

　　欲驗證同儕影響是否會正向影響高職教師採用教學部落格；結果顯示在 0.05 顯著水準下，係數值為-0.082，*p*-value 為 0.557 未達顯著，表示同儕影響不會影響教師是否採用教學部落格。對教師而言，同儕指的是同樣具教師身分的同事。在學校單位中，學校教師之間彼此的關係互相牽連，但卻保持各自的獨立性（Weick, 1976），此外教師的專業自主性高，因此雖會受到同事的影響，但大多教師最後仍依其自我的專業判斷來做決定（趙鏡中，2007），這突顯出教師受到周遭同事的影響有限。研究結果顯示同儕影響對於高職教師是否採用教師部落格的決策不會造成影響。

伍、結論與建議

一、研究結論

　　教學部落格不同於一般部落格，教學部落格不像其他領域部落格（例如交友、旅遊、美食等）呈現顯著成長。在台灣教育方面，又以高職學校的採用比例最低。因此本研究以高職學校教師為研究對象，探討高職教師採用部落格的影響因素，以瞭解高職教師採用教學部落格的關鍵因素。本研究以 Jeyaraj 等人（2006）的個人-科技-組織-環境架構為主軸，從個人創新採用及知識分享的文獻，發展一個整合的架構來探討高職學校教師採用教學部落格的影響因素。研究結果發現個人特性中的編碼化辛勞與個人創新特質；創新特性中的認知易用、相容性和認知愉悅與學校特性中的學校支持與學校獎勵是影響教師採用教學部落格的關鍵因素。這些關鍵因素的相對重要性依序為: 編碼化辛勞、認知愉悅、學校獎勵、個人創新特質、相容性、學校支持和認知易用。

　　當教師認為在需要花費較多心力與時間去維護部落格與貢獻知識到部落格中，這樣會降低教師去採用教學部落格；相反的，當教師覺得花費的時間和辛勞愈少，則較願意去採用教學部落格。教師具有個人創新特質，願意拋棄舊有的做法去嘗試新的做法，且教學部落格亦是一種新興的資訊科技，較具個人創新特質的教師亦會比一般教師更容易採用教學部落。其次，教師認為部落格的使用愈容易，愈容易去維護和更新他們的網站，會顯著影響採用教學部落格與否；而教學部落格的前身即是個人網站，大多教師都有接觸網站的經驗，教師習慣於用網站的取得知識，相對的亦會利用此方式來輔助教學，且教師認為使用教學部落格是愉快的、輕鬆的，會顯著影響教師採用教學部落格。最後，基本上學校教師採用教學部落格是得花費額外的時間、心思與維護，可能主要目的是要提供師生學習、溝通的平台，而非為獎勵而去做，若學校能適時的獎勵與支持教師，會顯著影響採用教學部落格與否。

二、研究貢獻

　　本研究之研究貢獻將分成學術面及實務面兩方面來說明：

（一）學術面

　　本研究提供一個整合架構以瞭解高職教師採用教學部落格的影響因素，從個人、科技、學校和環境四大構面來探討影響高職教師採用的關鍵考量因素，本研究可以做為往後欲探討其他學校層級（例如國小、國中）教師採用教學部落格相關議題的參考。本研究的應變數是

教師對於教學部落格的採用與否。未來研究建議進一步探討採用之後的滿意度（Satisfaction）與教學成效（Effectiveness）等的影響。這樣可以進一步瞭解其採用的影響效果。另外，研究結果顯示關於個人特性、科技特性及學校特性的因素對於是否採用教學部落格有較顯著的影響。在環境構面均未有關鍵的影響因素，未來研究可以探討其他環境有關的影響因素，例如「下屬特性」也就是學生對教師採行教學部落格的影響。

（二）實務面

1.對高職學校而言

　　編碼化的辛勞是降低高職教師採用的最重要影響因素，Kankanhallil 等人（2005）建議，當員工間的一般化信任（Generalized Trust）愈高時，知識貢獻者相信知識接收者會適當的使用他們的知識，而且能認可他們在編寫上的辛勞。在這種情況下，知識貢獻者相信他們的辛勞將被感激，因此可能不擔心他們必須付出的辛勞。相反的，如果知識貢獻者不信任知識接收者時，知識貢獻者認為知識接收者不會恰當的使用自己所貢獻的知識，那麼知識貢獻者就不會努力的貢獻自己的知識（Markus, 2001）。因此在推行高職教師採用部落格時，教師與教師之間或師生之間的信任變成了一個十分重要的關鍵因素。倘若雙方在知識交換的過程中可以建立彼此良好的信任關係，這樣有助於降低教師因為編碼化辛勞排斥採用教學部落格的意圖。

　　學校支持與學校獎勵是促使高職教師採用教學部落格的影響因素。因此本研究建議若高職學校欲推動教師部落格建置時，應有明確的發展方向與資源規劃，當教師在採行教學部落格的過程中有需求或困難時，學校應提供其所需的資源及輔助。此外學校也可藉由表揚優良教學部落格及提供誘人的獎勵來吸引教師採用教學部落格。

　　由於教師本身的個人創新特質，對於採用教學部落格具有顯著的影響，因此本研究建議可集合較具創新特質的教師們組成小組，做為推行小組，以協助推行教學部落格。

2.對部落格服務供應商（Blog Service Providers, BSP）而言

　　部落格的科技因素對於教師是否採用部落格具有決定因素。尤其認知愉悅和認知易用比起認知有用具有更強的影響。這個研究結果和 Hsu 與 Lin（2008）的研究發現一致。Hsu 與 Lin 的研究對象是台灣的無名小站、Yahoo、新浪網、PChome 等大型的部落格。在他們的研究沒有區分部落格的類型，因此包括有一般主題如個人日誌，也有特殊主題如財務投資與新科技應用等，他們的研究結果顯示認知愉悅和認知易用會建立部落客使用的積極態度。本研究應用在教學部落格，結果顯示高職教師採用部落格的決定因素（1）與部落格互動所感覺到的愉悅程度；（2）運用自如的使用部落格系統。因此本研究建議部落格要能容易發佈與維護是很重要的。另外部落格的設計要能促進社交互動性，以提昇使用的愉悅感受。

　　由於編碼化的辛勞對高職教師是否採用教學部落格具有顯著負向影響。為了降低這種影響，來自部落格服務供應商的各種技術的支援和線上的教學指引能幫助使用者在使用過程結省操作的時間和降低困難。

三、研究限制

　　在研究限制方面分為以下四個部分。第一個部份為本研究的受測對象只侷限在 45 間高職學校，建議後續研究可以調查更多的高職學校教師，以增加樣本代表性。第二個部份，本研

究回顧過往的資訊科技採用與部落格知識分享的研究，為了能儘可能的包含解釋教師採行教師部落格的影響因素，總計採用了 14 個影響因素，並盡量不合併或刪減變數，但因為變數過多容易使解釋的效果被分散，使得研究結果的某些變數顯著性會降低。第三個部份為本研究只探討教師是否採用，建議後續研究可以針對在採用之後的應用程度做更為深入的探討。第四個部份為本研究發現各因素彼此間可能會互相影響，且教師考慮是否採用教學部落格，亦不會針對單一動機作考量，而是考量多個動機的交互作用及相對影響後所做出的決策，建議後續研究可以輔以個案訪談以更瞭解這些因素間的關係。

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奈米科技前瞻人才產學合作訓練規劃與滿意度評估

A Study on Training Design and Trainee's Satisfaction of Talent Development in Nanotechnology Based on University-Industry Collaboration

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摘要

　　奈米科技近年來風靡於全球，各先進國家多在國家政策中推動奈米科技研究，並結合奈米科技的人才培育。臺灣大學奈米機電系統研究中心在 2009 及 2010 年進行跨領域奈米科技前瞻人才培育計畫，透過學術單位與產業界連結，規劃奈米科技理論與實務的一系列課程；學員除研究生外，亦包含學術研究機構及業界研發人員。本研究以探討此人才培育計畫為主，旨在透過教學滿意度問卷，就培訓學員對整體教師教學、課程偏好等教學滿意進行態度調查，研究對象為參與 2009 與 2010 年奈米機電系統基礎技術培訓班的學員共計 140 位。經由描述性統計、複選題分析、柯克蘭 Q 考驗等統計方法進行資料分析，並彙整歸納學員對課程與教學提出的建議與回饋。研究結果發現：(1)不同年度課程學員在整體教學滿意度有所提高；(2)學員課程偏好上以「未來新興產業」與「能源科技」等議題最為滿意；(3)學員提出幾項建議，希冀能給未來主辦相關訓練課程之機構、教師教學與課程規劃之參考。

關鍵字：人才培育、奈米科技、教學滿意度、產學合作

Abstract

　　Nanotechnology has already been applied on all kinds of researches and industries and had a prominent influence in the world. The policies of many developed countries point out not only they are devoted to promoting the nanotechnology research but also combining nanotechnology educational programs with industries on talent development. In Taiwan, the government launched a national nanoscience and nanotechnology program in 2002 to promote and cultivate new talents

who are able to develop the potential of nanotechnology. The Nano-Electro-Mechanical-Systems (NEMS) research center of National Taiwan University marks out a series of training courses for talent development taking advantage of resources between universities and nanotechnology industries. The purpose of this study is to explore and analyze instructional satisfactions and course preference from these trainees in the nanotechnology training programs. The research subjects are 140 participants took part in the training programs. Data analysis methods are as follows: descriptive statistics, multiple response analysis, and Cochran Q test analysis. In addition, researchers summarized trainee's feedback and recommendations from open-ended questions in the questionnaires. Finally, this study provides some conclusions: (1) trainee's instructional satisfactions are improved in the second year; (2) "Emerging Industry" and "Energy Technology" topics have the highest trainee's instructional satisfaction; (3) trainees proposed some recommendations that will assist instructors and curriculum developers of the NEMS center to proceed with further development in university nanotechnology courses.

Keywords: Talent development, Nanotechnology, Instructional satisfactions, University-industry collaboration

壹、前言

一、研究背景

由於近年來奈米科技的發展，使得傳統科學物理、化學、工程等研究領域朝向奈米尺度應用，奈米科技不僅使科學與技術創新，在學術界與各產業界皆有重大突破與影響。奈米科技是二十一世紀重要的科技發展，將不斷引領科學研究與產業發展的躍進，學者甚至預言此一發展將掀起全球第四次工業革命（Jotterand, 2006; Keiper, 2003）。隨著奈米科技大幅的創新發展，將會對各產業產生巨大的衝擊，世界先進國家均已陸續投下巨資，將奈米科技列為最優先發展領域。如美國聯邦政府於 2000 與 2001 年相繼投入 2 億 7 千萬美元與 4 億 9 千 5 百萬美元經費，致力於奈米技術研發；日本的經濟產業省（Ministry of Economy, Trade and Industry）每年投入研發經費為 6 千萬美元；又如德國的教育及研究部門（Ministry of Education and Research）每年投入 5 千萬美元於奈米工程的研發上，並於 1998 年建立 6 個競爭中心，以加速奈米科技的發展；在台灣，政府也於 2004 年投入 232 億新台幣的資金，推動為期 5 年的奈米國家型科技計畫，此外經濟部也於 2003 年起每年投入 231 億新台幣，致力發展奈米科技及其產業化應用，預估在 2012 年達兆元的產業年產值目標，同時配合相關基礎學術研究，促進奈米技術之商品化，期能藉產業優勢的挹注，成為世界奈米技術的先導地區之一。除了技術研發外，人才培育也是產業發展不可或缺的重點，Ernst（2009）提出奈米科技除應重視政府研究與商業價值，同時也應著重在奈米科技教育。因此，為厚植臺灣未來的競爭力，培養國家未來的奈米科技人才，進而提昇科學教育與工程教育品質，以及培育具備奈米科技素養的國民等目標，行政院國家科學委員會於 2002 年底開始以跨部會型式推動第一期「奈米國家型科技計畫」，並於 2003 年起由經濟部、工研院、中研院、教育部科技顧問室等合作推動奈米國家型科技計畫，其中包括了四項分項計畫：學術卓越研究計畫、產業化計畫、核心設

施研究計畫及人才培育計畫。同年教育部亦統籌執行「全國奈米科技人才培育計畫」，設立計畫推動辦公室統籌全國奈米科技人才培育相關事務，其中以「奈米科技前瞻人才培育計畫」針對大學及研究所課程、教學等相關系所學生進行培訓；此外「奈米科技 K-12 人才培育計畫」，主要針對中小學生對於奈米科技的基礎教育與認識進行向下紮根。透過政府積極推動奈米科技人才培育的政策來看，人才培育乃為國家奈米科技學術研究與產業發展的重要基石。

　　目前在任何一個致力於奈米產業發展的國家中，無不汲汲營營致力此新興科技的人才培育，因為決斷哪一個國家能取得競爭優勢的關鍵，在於其所擁有的奈米產業人才之質與量。台灣政府為了搶攻人力先機，近年來業已先後投入將近 4 億新台幣的經費，進行奈米人才的培育，而當透過訓練進行的人才培育，適「才」適「地」的訓練規劃，亦即立基於產業「人力特質」與「環境特性」等考量，進行訓練課程設計與方案的發展，才能獲致人力提升目標之達成；同時為確保訓練辦理符合預設目標與彰顯訓練成效，實施評估是必要之舉。職故，本研究旨在探討應用產學合作或產學資源整合模式的奈米產業人才培訓規劃，以及透過檢測受訓學員的學習反應，進行渠等訓練的成效評估，以呈現依此整合模式獲致的人才培訓之總結性效果及反應出的價值。

二、研究目的

　　整體而言，本研究隸屬於「奈米科技前瞻人才培育計畫」之一部份，在此所呈現與探討之研究目的涵蓋：（1）規劃與設計奈米科技產學培訓課程；（2）評估受訓學員對授課講師的教學滿意度；（3）調查受訓學員對課程主題的偏好情形；（4）探討受訓學員對課程的整體意見與建議，俾作為未來奈米科技人才培訓課程的規劃、調整與改進之參考。

貳、文獻探討

一、奈米科技前瞻人才培育

　　人才培育應從教育著手，近年來許多學者紛紛提出奈米科技人才培育的重要性及學校應該重視跨領域學科結合奈米課程設計、規劃的教育觀點（Fourez, 1997; Roco, 2002; Shelley, 2006）。國立臺灣大學奈米機電系統研究中心為培育奈米機電系統人才與基礎技術，以促進我國產業之發展，同時執行人才培育、技術研發與整合及促進產業發展等工作，2009 年與 2010 年分別邀請學術界與產業界之專業人士擔任訓練課程講師，兩年主題不盡相同，但主軸皆以奈米科技進行不同領域應用研發或創新的探討。

　　奈米科技為一門跨領域學科，且能運用在各研究領域及相關產業上，培育跨領域科技整合人才亦為國家型計畫發展的重點之一。因此，此培訓課程的訓練目的主要有三：（1）透過奈米科技領域的專家、學者授課，讓學生能掌握奈米科技的理論與研究；（2）透過業界的分享，讓學員能更清楚理論應用與產業發展趨勢；（3）透過理論與實務課程，讓學員能從理論課程進入實驗室實際操作，並且藉由產學交流促進學術界與產業界的接軌。而如同所有的產業培訓，為確保教育訓練的課程設計與規劃有助人才培育目標之達成，完善的前置規劃與訓後評估皆是必須，因此，本研究即著重在探討應用跨領域學科結合奈米之課程設計觀點所規劃的培訓方案，並藉檢視教學滿意度，呈現此訓練規劃的反應層次成效評估結果。

二、教學滿意度

Goldstein（1986）指出，訓練成效評估係指針對特定的訓練課程，進行系統性的資料蒐集，經分析後給予適當的評價，以裨益訓練管理者瞭解整體培訓成效與價值，並作為後續採用、篩選課程與修改方案規劃等相關決策擬定之參考依據。另 Baldwin 和 Ford（1988）以及 Noe（2001）等強調，訓練課程設計為攸關訓練遷移產生的重要影響因素之一；換言之，參訓學習者對訓練課程設計及課堂教學滿意度的反應，會對他們未來運用所學在實際工作行為上的遷移成效具顯著影響，故在此所探討之奈米科技前瞻人才培訓成效評估，主要以參與學員對課程的教學滿意度為研析重點。

Francken 與 Van Raaij（1981）認為滿意度是一種相對性的指標，通常在界定自我期待與實際情況之差距情形，當自我期待未被滿足時，自我會產生不滿的感覺，當自我期待滿足時，則會產生滿意的感覺。Martin（1988）指出，滿意是指個人在獲得經驗之期望，以及個人感受到該經驗與實際結果之間的一致性與否，當個人所感受到的情況為等於或超越所預期的，就會覺得滿意；反之，則感到不滿意。基此說法，Domer、Carswell 和 Spreckelmeyer（1983）將心理學的差異理論應用在學生學習滿意度方面，認為學生學習滿意度取決於個人的「期望水準」與「實際所得的結果」互相比較之後所得的差異程度。「期望水準」與「實際所得的結果」之間的差異越小，則學生越感到滿意；反之，則越不滿意。於教學過程，若學生對學習活動過程感到愉快，就會產生滿意的態度（Long, 1985）。綜合上述學者觀點可知，教學滿意度是指學生對於教學活動的內容、方式、過程、教學環境安排、學習成效等綜合評估，若符合學生的期望為「滿意」，若不符合學生期望則為「不滿意」。Harnash-Glezer 和 Meyer（1991）認為教師為影響課程教學滿意度的主要關鍵因素，因為教師為教學最主要的貢獻者，故為影響課堂教學滿意度最重要的影響因素。此外 Marsh（1987）的研究發現，不管課程的難易與否，學生給予正面評價的意願並不受其影響。另滿意度仍是目前最廣泛運用於評估訓練效果的檢核指標之一（Noe, 2001），因此透過教學滿意度的評估，除可獲知學員對培訓所持態度看法外，更有助瞭解所提供的課程經驗符合學習者期望水準的情形，藉以評估訓練成效。

三、產學合作教育訓練規劃

（一）產學合作之理論與實務整合設計

奈米科技的教學與學習無法只侷限於單一的科技領域，也不能只是簡單地將傳統各科技領域進行多領域整合，而是需建立一種新的跨領域（cross-disciplinary）課程與教學機制，在教學、學習或訓練體系中，培養學生具備跨領域與整合學習之能力。而在課程規劃與發展方面，也應仔細釐清既有學門之學科領域知識與能力、以及跨領域與學科整合間的連結關係，讓學生可循序漸進並有統整之學習。如同 Hersam、Luna 和 Light（2004）提出奈米科技的研究必須從跨領域的問題脈絡範疇中，連結他們的專業知識與專家觀點。工程教育無法自外於產業發展，因此在課程規劃設計的層面，往往會考慮產學的連結或合作，包括學校課程如何與產業合作（Alford, Catati & Binks, 2007），或者如何幫助產業進行在職訓練（Koehler & Koehler-Jones, 2006）。下圖一為 2009 年與 2010 年培訓研習課程設計之整體概念呈現，該研習課程最大特色乃是以奈米科技為核心概念，先充實學術理論基礎，再透過業界專業人員的產業應用分享，最後進行實驗室見習與實作，此為工程教育著重的理論與實務並行，透過產學合作課程讓學生能對業界發展與理論之實際應用能有所掌握。
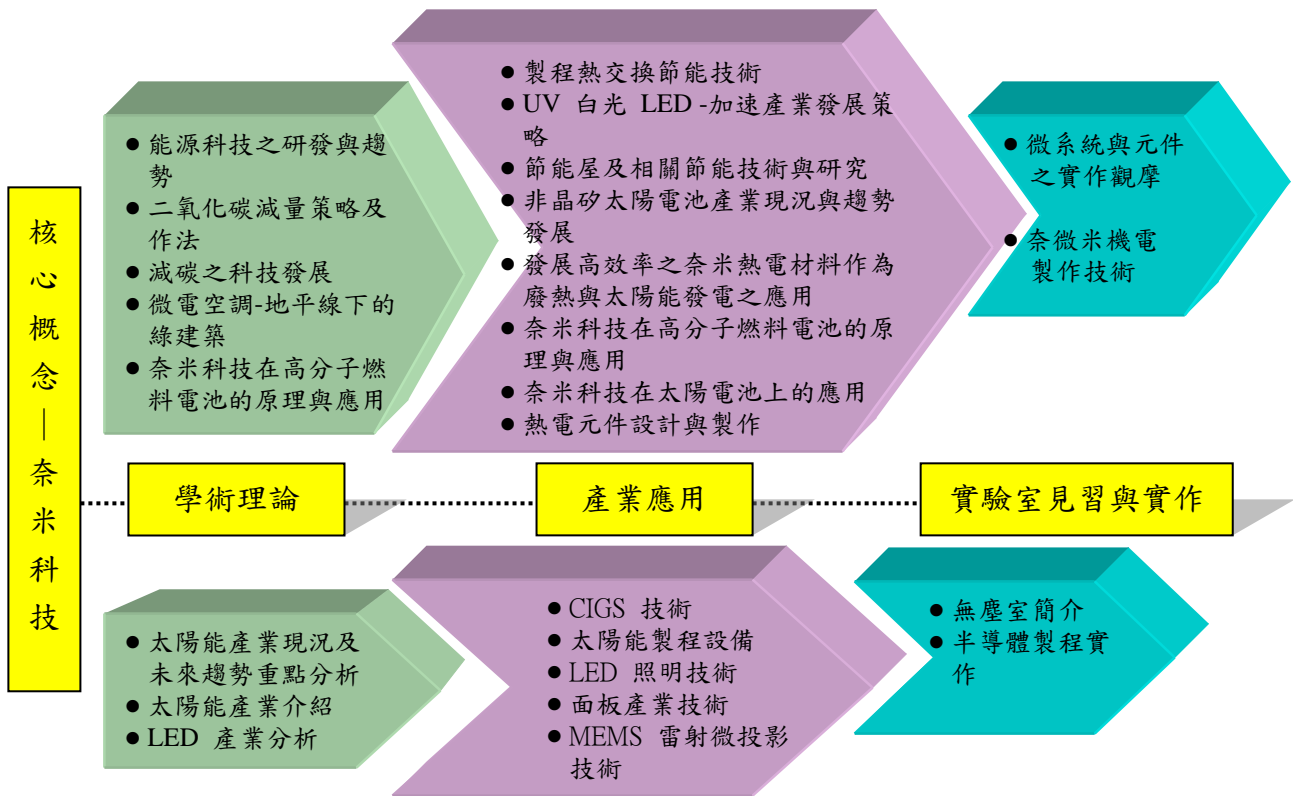
圖一　奈米機電系統研習課程規劃

（二）2009 年節能減碳與奈米科技培訓課程

　　近年來油價高漲及碳排放導致氣候異常等問題，引發大家對於能源短缺、降低碳排放等問題的重視，2009 年中心特別以「節能減碳與奈米科技」為主題開設培訓課程，課程規劃主要針對節能減碳科技趨勢與發展、奈米光電節能技術、綠色能源科技等三大主題，下表 1 為「2009 年奈米機電系統基礎技術培訓班—節能減碳與奈米科技課程」相關資訊，此培訓課程主要邀請國內產業專家與學界教授進行理論與實務分享，並安排學員進入奈米機電系統研究中心的無塵室進行觀摩實作，課程針對奈米技術對於節能減碳之理論原理、應用面、技術面及發展現況與趨勢等，進行全面且系統化地學習；希冀學員能在培訓課程中，建立對奈米科技的基本認識。

表 1　2009 年奈米機電系統基礎技術培訓班-節能減碳與奈米科技課程

產業類別	課程名稱/講員	內容概述	產學
8/17 節能減碳科 技趨勢與發 展	能源科技之研發與趨勢 國立臺灣大學機械工程學系教授	介紹能源科技之研發過程與趨勢。	學界
	二氧化碳減量策略及作法 國立清華大學化工系教授	提出現行二氧化碳減量策略及具體作法。	學界
	減碳之科技發展 國立臺灣大學環境工程學研究所教授	簡介減碳科技的理論實務與發展。	學界
	微電空調-地平線下的綠建築 國立臺灣大學機械工程學系教授	微電空調的設計與運用在地平線下的綠建築。	學界
8/18 奈米光電節 能技術	製程熱交換節能技術 工研院能源與環境研究所研究員	製程熱交換理論與實驗研究,與運用在節能議題。	學界
	UV 白光 LED -加速產業發展策略 工研院電光所研究員	UV 白光 LED 的運用與產業發展與策略運用。	學界
	節能屋及相關節能技術與研究 工研院材料與化工研究所研究員	介紹節能技術之理論與實務,並運用在節能省電屋的概念設計。	學界
	非晶矽太陽電池產業現況與趨勢發展 精曜科技股份有限公司研究員	非晶矽太陽電池的理論應用與產業發展現況與未來發展趨勢。	業界
8/19 綠色能源科 技	發展高效率之奈米熱電材料作為廢熱與太陽能發電之應用 中研院物理研究所研究員	高效率之奈米熱電材料之發展介紹並運用在廢熱與太陽能發電之介紹。	學界
	奈米科技在高分子燃料電池的原理與應用 國立清華大學化學工程系教授	奈米科技運用在高分子燃料電池的理論、實驗研究與應用	學界
	奈米科技在太陽電池上的應用 工研院太陽光電中心研究員	奈米科技運用在太陽能電池上的理論、實驗與應用。	學界
	熱電元件設計與製作 國立虎尾科技大學教授	熱電元件設計原理與製作技術介紹。	學界
8/19 實務課程	奈微米機電製作技術 臺大奈米機電系統研究中心研究員	奈微米機電中心實驗室簡介。	學界
	奈微米機電製作技術 臺大奈米機電系統研究中心研究員	奈微米機電製作技術實務課程。	學界

※備註:2009 年奈米機電系統基礎技術培訓班課名使用中文。

（三）2010 年綠色奈米科技培訓課程

　　由於環保意識高漲及能源短缺的問題日益嚴重,太陽光電產業因為上述問題變得更為熱門,為提升國人的知識素養,並協助國家推動太陽光電產業發展,希望藉由「綠色奈米科技」的技術促進綠色能源、環保節能等研究方向與產業發展。因此,2010 年訓練課程針對太陽能產業、LED、新型顯示技術等新興科技,提供最新產業技術與市場發展趨勢,同時課程內容編排由淺入深,希望讓不同領域的學員們也能夠了解最新奈米科技相關產業的趨勢發展,達

到跨領域奈米科技人才培育的目標。鑑於 2009 年課程教學規劃以學界教師授課為主，2010年則改採納入產業界專業人士授課為主，以更強化理論與實務連結，課程主要針對奈米科技之應用面、技術面及發展現況等作一完整闡述，同時安排學員進入無塵室進行觀摩實作，使得學員能在最短的時間內，建立對微奈米科技之完整認識。下表 2 為「2010 年奈米機電系統研究中心培訓班-太陽能產業課程」相關資訊。

表 2 2010 年奈米機電系統研究中心培訓班-太陽能產業課程

產業類別	課程名稱/講員	內容概述	產學
8/16	PV Market Overview	太陽能產業的市場概況與發展趨勢。	業界
太陽能產業	ISuppliCorporation 資深顧問		
	Solar energy and sustainable operation	太陽能源的發展與永續經營的理念與	業界
	茂迪股份有限公司總經理	市場現況。	
	Thin-film Cu(InGa)Se$_2$ Solar Cells	銅銦鎵二硒薄膜太陽能電池的研發與	學界
	工研院綠能所研究員	應用。	
	Technical Development of Crystalline Solar Cell in Process and Equipment	結晶太陽能電池的技術發展理論與應用及設備介紹。	業界
	均豪精密工業股份有限公司副總經理		
8/17	The Future Star of LED Industry	明日之星-發光二極體(LED)的產業發	業界
LED 產業&	第一金證券投資顧問股份有限公司產業研	展現況與趨勢分析	
顯示投影技	究員		
術	Key Issues of Solid State Lighting	介紹固態照明在產業研發上的關鍵議	業界
	億光電子工業股份有限公司研發處處長	題	
	Future and Novel Display Technologics	介紹未來與新型顯示器的實驗研究與	學界
	國立交通大學電子工程系教授	發展趨勢。	
	MEMS Laser Pico-Projection	為奈米機電系統原理運用在激光微型	業界
	先進微系統科技股份有限公司總經理	投影之發展與產業現況。	
8/18	無塵室簡介與參觀	奈米機電系統研究中心之無塵室簡介。	學界
半導體製程	臺大奈米機電系統研究中心研究員		
實作	半導體製程實作	半導體製程實作課程。	學界
	臺大奈米機電系統研究中心研究員		

※備註：2010 年奈米機電系統基礎技術培訓班課名使用英文。

　　因此，本研究探討的奈米科技前瞻人才產學合作教育訓練計畫，2009 年課程主題為節能減碳與奈米科技，2010 年為綠色奈米科技領域的太陽能、LED 及顯示技術。課程設計規劃除邀請學術界、產業界專家來授課，並針對主題授予基礎理論知識、進行產業介紹與分析和討論技術發展與應用等之外，最後以實驗室見習與實驗實作，做為培訓課程整體學習成果之檢驗。

參、研究方法

一、研究對象

　　本研究對象設定為參加 2009 與 2010 年臺灣大學奈米機電系統研究中心培訓班的學員。2009 年參加學員人數為 70 人，填答教學滿意度問卷者有 57 人，其中大學部學生 2 人（3.5%）、碩士班學生 45 人（78.9%）、博士班學生 4 人（7%）、其他學術單位研究人員 3 人（5.3%）與研究助理 3 人（5.3%）。2010 年的學員共 70 人，填答教學滿意度問卷有 47 人，其中大學部學生 4 人（8.5%）、碩士班學生 39 人（83.0%）、博士班學生 3 人（6.4%）、來自其他學術單位研究人員 1 人（2.1%），填答問卷學員的資料詳見下表 3。

表 3 填答問卷之學員資料分析

	2009 年		2010 年	
身分	人數	百分比	人數	百分比
大學部學生	2	3.5%	4	8.5%
碩士班學生	45	78.9%	39	83.0%
博士班學生	4	7.0%	3	6.4%
其他學術單位	3	5.3%	1	2.1%
研究助理	3	5.3%	0	0%
總計	57	100%	47	100%

二、研究工具

　　為探討研習學員對培訓班的課程與教學滿意情形，由奈米機電系統研究中心成員組成跨領域研究小組，包含課程專家、教學專家、教學科技專家、工程教育專家、奈米科技專家等學者共同設計「奈米機電系統基礎技術培訓班課後教學滿意度調查表」。該調查表為五等量表，讓學員依據自己的上課感受填答，分數越高則代表越滿意；反之，則代表越不滿意。問卷設計包含三部份，分別為（一）個人基本資料共有三題、（二）總體教學效果與課程偏好共有十一題、（三）開放式問題共有三題。2009 年與 2010 年問卷教學滿意度 Cronbach's Alpha 值分別為 0.78 與 0.86，均為可接受的信度值。

三、實施方法

　　學員教學滿意度問卷施測時間均為研習課程的最後一堂，學員可依照個人教學滿意情形、課程偏好與回饋建議等不記名填答。最後所取得的有效問卷再透過 SPSS 統計軟體進行資料整理與分析；量化資料的分析採用描述性統計、複選題分析，以及檢驗重複測量之類別資料差異性的柯克蘭 Q 考驗（Cochran Q-test）等統計方法（Sheskin, 2004），其中柯克蘭 Q 考驗用以分析受訪學員對課程組成類型偏好的差異，旨在探討學員對課程類型所持偏好情形。至於開放題的回饋意見則透過編碼、分類、歸納等策略進行分析。

肆、研究結果

一、學員課程教學滿意度評估

　　表 4 彙整兩個年度學員針對受訓課程的教學滿意度評估情形，由表中可得知兩年度的教學評估各題目得分均為 3.7 以上，其中在 2009 年整體的教學滿意度平均為 3.89，2010 年整體教學滿意度平均為 4.11，顯示學員對這兩年培訓課程的教學，皆持正向滿意的看法；此外，當中涉及教師準備與表現的 6 個題項（表 4 中第 3~8 題）滿意度部份，2010 年平均數為 4.14，超過 4.0 且高於當年度的整體教學滿意度平均數，由此可推論增加業界師資比例實屬可行之策略。而兩年度均以「老師對課程本身的專業知識與經驗甚為勝任」為最滿意，反應培訓課程所邀請的講師均具備有專業知識與經驗。此外，兩年度教學滿意度達 4.0 以上的項目，除了老師對課程本身的專業知識與經驗甚為勝任之外，另有老師在上課前顯然有充分的準備與老師上課的態度非常熱誠、認真、負責，顯示邀請來的授課講師教學態度良好且事前準備均非常用心，而受到學員肯定。

表 4 學員教學滿意度評估

教學滿意度題目	2009 年 平均數	2010 年 平均數
1.總體而言，課程的內容及範圍有適當的計畫及安排	3.82	4.15
2.總體而言，課程的進度及時數安排有適當的規劃	3.79	4.09
3.總體而言，老師在上課前顯然有充分的準備	4.18	4.26
4.總體而言，老師對課程本身的專業知識與經驗甚為勝任	4.39	4.38
5.總體而言，老師講解的表達方式很好，解釋清楚又生動	3.74	4.09
6.總體而言，老師上課的態度非常熱誠、認真、負責	4.28	4.21
7.總體而言，老師在課堂上的講解激發了我的興趣並促使我認真學習	3.64	4.02
8.總體而言，老師所指定或提供之教材、參考文獻等閱讀資料十分有幫助	3.73	3.85
9.總體而言，此培訓課程對於我進入此專業(當年主題)領域的幫助很大	3.65	4.00
10.總體而言，我認為此培訓課程的教學效果非常好	3.72	4.02
全部	3.89	4.11

二、學員偏好課程

　　本研究進一步分析學員們是否有特別偏好的課程，採複選題選項問答。首先透過柯克蘭 Q 考驗，Q 的檢驗值為 72.800(a)、自由度 11、$p<0.05$，達顯著水準；表示學員對課程偏好有顯著差異。下表 5 為 2009 年奈米機電系統培訓課程最滿意的課程評選結果，因 57 位學員中有 2 位學員並未填答，故以所有課程學員圈選次數的總和（N=233)除以答題的學員數（n=55），可得每個學員平均選了 4.236 的課程為最滿意的課程。由表 5 中可看出學員最為滿意的課程類別為「綠色能源科技」課程、共有 96 次（41.2%），其次為「奈米光電節能技術」類、共有

79 次（33.9%），「節能減碳科技趨勢與發展」類、共有 58 次（24.9%）。其中又以「非晶矽太陽電池產業現況與趨勢發展」為 2009 年最受學生滿意的課程。

表 5 2009 年培訓課程最滿意的課程評選

類　　別　課　　程	各類別累計	學員圈選次數	佔總回答次數百分比	佔總回答人數百分比
節能減碳 1.能源科技之研發與趨勢		17	7.3	30.9
科技趨勢 2.二氧化碳減量策略及作法	58	13	5.6	23.6
與發展 3.減碳之科技發展	(24.9%)	7	3.0	12.7
4.微電空調－地平線下的綠建築		21	9.0	38.2
奈米光電 5.製程熱交換節能技術		14	6.0	24.5
節能技術 6.UV 白光 LED－加速產業發展策略	79	18	7.7	32.7
7.節能屋及相關節能技術與研究	(33.9%)	14	6.0	25.5
8.非晶矽太陽電池產業現況與趨勢發展		33	14.2	60.0
9.發展高效率之奈米熱電材料做為廢熱與太陽能發電之應用		32	13.7	58.2
綠色能源 10.奈米科技在高分子燃料電池的原理與應用	96	32	13.7	58.2
科技 11.奈米科技在太陽電池上的應用	(41.1%)	10	4.3	18.2
12.熱電元件設計與製作		22	9.4	40.0
總計		233	100	423.6

柯克蘭 Q 的檢驗值為 72.800(a)、自由度為 11、$p<0.05$

　　表 6 為 2010 年學員們是否有特別偏好課程的複選題分析結果，透過柯克蘭 Q 考驗，Q 的檢驗值為 27.087(a)、自由度 7、$p<0.05$，達顯著水準；表示學員對課程偏好有顯著差異。繼續採用複選題分析結果，由於 47 位學員中有 1 位學員並未填答，故以所有課程學員圈選次數的總和（N=141）除以答題的學員數（n=46），可得出每個學員平均選了 3.065 的課程為最滿意的課程，而其中最為滿意的課程類別為「太陽能產業」課程、共有 73 次（51.8%），其次為「LED」類、共有 41 次（29.1%），「新型顯示技術」類、共有 27 次（19.1%）。其中又以「Solar Energy and Sustainable Operation」為 2010 年最受學員滿意的課程。

表 6 2010 年奈米機電系統培訓課程最滿意的課程評選

類　別	課　　　程	各類別累計	學員圈選次數	佔總回答次數 百分比	佔總回答人數 百分比
太陽能產業	1. PV Market Overview - iSuppli Corporation		12	8.5	26.1
	2. Solar Energy and Sustainable Operation	73	29	20.6	63.0
	3. Thin-film Cu(lnGa)Se 2 Solar Cells	(51.8%)	15	10.6	32.6
	4. Technical Development of Crystalline Solar Cell in Process and Equipment		17	12.1	37.0
發光二極體(LED)	5. The Future Star of LED Industry	41	17	12.1	37.0
	6. Key Issues of Solid State Lighting	(29.1%)	24	17.0	52.2
新型顯示技術	7.Future and Novel Display Technologies	27	11	7.8	23.9
	8. MEMS Laser Pico-Projection	(19.1%)	16	11.3	34.8
	總計		141	100	306.5

柯克蘭 Q 的檢驗值為 27.087(a)、自由度 7、$p<0.05$

三、學員課程綜合建議

　　最後針對學員參加培訓課程的開放題回饋建議進行分析彙整，分別歸納得到關於課程方面、希望聽到主題與其他建議等三方面的議題。綜合 2009 年的學員在課程方面建議可得（1）課程內容宜增加技術實務，且內容勿重複與過多：受訪者提出如下佐證：「除基礎理論及製程技術、設備介紹外，增加技術上的實務內容；避免課程內容重複；避免教學內容過多時，講師無法教完所有內容。」（2）同質性的課程宜安排在同一天，並多提供實例以提升學習效果：受訪者提出如下佐證：「將同質性高的課程安排在同一天；期望未來講師能提供教學實務的短片為實例，如此學習效果將會更佳。」（3）講師宜強化教學互動，另建議以中文輔助說明科技專業英文詞彙，以提高學生理解程度：受訪者提出如下佐證：「師生互動可再加強；課程內容資料豐富，然講解到最後有些匆促；講師使用科技專業英文用語時，建議可用中文輔助說明。」其中，關於「科技專業英文詞彙使用」的建議為最多學員所提及。

　　在未來課程主題方面的建議如下：希望聽到的主題有核能及風力發電介紹、相關製程技術精解說明、奈米科技在各產業的技術應用、產業發展現況及未來重點、綠建築相關資訊、科技法律的應用與實例、機器人自動化的課程、熱電材料和最新燃料電池等。在其他建議方面，教學環境之座位可照亂數編號順序安排，以增進互動；主辦單位很用心，希望下次可擴大舉辦。

　　另一方面，2010 年學員在課程方面的建議包含（1）課程內容宜增加基礎理論與產業實務，且內容勿過多：受訪者提出如下佐證：「多一點基礎理論及產業面向介紹；避免內容重複性；避免課程內容過多時，講師無法教完所有內容。」（2）一天的課程時數安排不宜過多，且應增加產品實例的介紹：受訪者提出如下佐證：「一天時數過多；希望有實際樣品或產品可看。」（3）講師教學應對專有名詞詳加說明，且講解速度宜再調整並增加上課時間：受訪者提出如下佐證：「希望教師提到的專有名詞能更深入解說；針對某位教師的教材資料太多，導致上課講解速度較快，學員不容易吸收；希望能增加上課時間。」在未來課程主題方面：希

望聽到主題有燃料電池、生醫感測、機電整合、有機半導體及半導體封測等五個大方向。在其他建議方面，學員希冀能*多舉辦此類的學術性課程，或於每季舉辦一次以有利於產學交流*。當中以「避免研習內容之重複性」為較多學員提出的回饋。

　　綜合這兩年的研習學員皆提到的共同建議包括：（1）在課程內容與主題：希望能多增加理論與實務技術上的課程內容，且均提到「燃料電池」、「機電整合」兩課程的增設；（2）課程安排：希望同一天課程時數不宜過多，且若能提供研究領域或研發過程的教學實務短片為實例輔助，學習效果將會更佳；（3）講師教學：當提到專有名詞時，要能更深入解說詳細，另教材準備應適量，以讓學員能吸收理解為主；（4）未來應多舉辦此類的研習課程，將有利於產學交流。綜觀兩年研習學員的建議，前述意見回饋對未來培訓課程規劃皆有重要的參考價值。

伍、結論與建議

　　透過產學合作教學運用在跨領域奈米科技前瞻人才培育之教育訓練課程，讓學員不僅能擁有學術理論知識以為基礎，更能讓受訓學員掌握產業界最新的動態與未來發展，而依本研究評估所得發現，兩年的培訓學員反應在課程上的整體教學滿意度於第二年有所提高，其中「老師在上課前顯然有充分的準備」、「教師專業知識與經驗」、「老師上課的態度非常熱誠、認真、負責」等三項，在這兩次培訓課程中均被學員高度肯定、教學滿意度皆為最高的前三名；此外，在學員表達出的課程偏好方面，2009 年最為滿意的課程類別為「綠色能源科技」課程，2010 年學員最為滿意的課程類別為「太陽能產業」，顯示學員對學習內容的偏好在未來新興產業、能源科技等議題的學習上有極大興趣。此外，當就學員的不同背景特性，進行培訓課程的教學滿意度與類型偏好之差異分析時，應可提供更深入的課程規劃相關資訊以作為決策訂定之依據，但因本研究目前受到所得資料與樣本之限宥，故建議未來在執行相關訓練評估研究時，可深加考量參訓學習者的背景因素，進一步瞭解學員背景影響教學滿意度與課程偏好之情形，以作為未來課程規劃是否依背景採分流教學之參考。此外在評估方法上，雖本研究調查已納入開放題的回饋意見進行探討，所得結果仍相當有限，因此，建議爾後類似的評估研究設計，除可佐以學員的深度訪談，彌補問卷調查可能產生的限制外；在訪談大綱的規劃，亦應考量與問卷調查內容相互對應一致，以利後續的比較分析，藉此強化研究結果的廣度與深度。

　　至於在課程建議方面，學員希望能多增加理論與實務技術上的課程，避免課程內容重複，且同一天課程時數不宜過多，且若教師能提供教學實務影片或實務樣品可供觀摩，將可提升學習效果。此外，針對授課講師進行講解時，希望能清楚解釋英文專業用語，而於課程主題方面，未來可增加規劃令學生更感興趣的議題，並期望主辦單位能繼續舉辦此類研習訓練課程。

　　綜合上述，本研究提出若干建議如下，希冀能提供給相關機構在從事跨領域、跨學科的科技人才培訓時之參考。

一、跨領域的科技人才培訓，講師遴聘應產學並重。奈米科技為跨領域議題，因此在課程設計與規劃上，除了考量跨學科、領域相關背景的學界專業講師之外，所邀請的產業界講師比例亦應並重，讓此類培訓課程兼俱基礎理論與產業實務，以彰顯產學合作教學的培訓特色。

二、「燃料電池」、「機電整合」兩大議題最為受訓學員所關注與偏好。兩年度的研習學員均一致地提出，希望未來的相關培訓能增加此兩個議題。因此，未來在課程主題規劃上，建議應可考量增加此類課程。

三、課程內容應確保理論與實務並重，並加強實驗室的訓練等學習活動設計。在課程內容規劃方面，事先商請授課講師在教學內容的規劃、安排與設計上，能充份整合基礎理論內容與實務經驗，以進行研究分享，並搭配實驗室的實務訓練課程，以確保理論與實務並重的培訓特色。

四、授課過程中，當使用專業術語或工程英文時，需進一步清楚解釋以讓學員易懂。兩年度的受訓學員均提到，授課過程中講師會使用專業學科的英語詞彙與工程用語，有時導致非相關領域背景的學員無法理解，因此建議在未來研習授課前，應事先與授課講師溝通，當使用專有工程英文與詞彙時，應適時地補充說明，讓學員能充份理解並掌握授課內容。

五、　課程的教材內容應適量，讓學員能充份吸收學習。鑑於部份講師準備的課程教材、講義等資料內容過多，導致講師無法於課堂講解完畢所提供之內容，或僅能採快速瀏覽教材內容的方式進行教學。因此，未來課程規劃上，建議應就此點與講師進行商討溝通，在教材內容的準備上能適量即可，有助於提高教學效率與學員吸收能力。

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Psychological and Environmental Predictors of Student Imagination: The Mediating Role of Generative Cognition

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Abstract

This study aimed to explore what psychological and environmental influences stimulated imagination in education major university students. In addition, it was assessed to what degree these influences had on student imagination. The participants in this study were two groups of students from eight education programs. Sample one ($n = 402$) served as the calibration sample for testing the most appropriate structures of imaginative capability scale and psychological/environmental influence scales, using exploratory factor analysis. Sample two ($n = 380$) served as the validation sample using confirmatory factor analysis for validating the factor structure from sample one, and establishing the predictive model. The results of this study supported that imagination consists of nine capabilities, namely crystallization, effectiveness, elaboration, exploration, intuition, novelty, productivity, transformation, and sensibility. The psychological influences regarding imagination stimulation were comprised of six factors, namely: intrinsic motivation, self-efficacy, inspiration through action, stress, emotion, and generative cognition. The environmental influences of imagination-stimulation were composed of four factors, namely: social climate, organizational measure, physical component, and human aggregate. The hypothesis of the study that *generative cognition* plays a mediating role on imagination-stimulation was partially supported. The structural model also showed that variables of *intrinsic motivation*, *emotion*, *self-efficacy*, and *organizational measure* have significant, indirect effects on imagination.

Keywords: Environmental influences, Generative cognition, Imagination, Mediating effects, Psychological influences

1. Introduction

Young children see the world in a fresh and vivid way, often having considerable opportunities to choose how to express their ideas. This creates a positive climate for young children to realize their imagination and show their creativity. In addition, pre-school teachers usually use role play, music making, expressive painting, and imaginative movement to promote children's creativity. Indeed, imagination is one of the most important cognitive capacities for learning in that "it permits us to give credence to alternative realities" (Heath, 2008, p. 115). However, imagination can gradually vanish as people grow up due to various discouraging life experiences. These discouragements can increasingly limit the power of exploration, discovery, and practice.

In response to this phenomenon, many educational programs around the world have been launched. One of the most progressive developments of curriculum in higher education can be found in the activities of the UK Higher Education Academy - Imaginative Curriculum Project. At the heart of this project is a campaign to encourage higher education to give greater attention, to its role in developing student creativity. This initiative has created a network of educational practitioners who believe that designing a curriculum is a creative process in which knowledge, skills, imagination and passion for a subject come together (Hicks, 2007). The Imaginative Curriculum Network is a cross-disciplinary community of people who provide practical help to teachers, who want to develop their curricula in ways that are more likely to foster student imagination and creativity.

Kress (2000) held that curriculum is a design for the future. A curriculum should provide important means and resources for the individual's transformative action into making themselves socially human. Although earlier studies in the field of education appreciated the value of imagination contributing it to this transformative action (e.g., Heath, 2008; Thomas, 1999), little work has been done pertaining to the variables responsible for imagination, let alone developing an evaluation tool for assessing imagination. Taking these concerns into account, this study aimed to explore what psychological and environmental variables influenced the imagination of education major university students, and the effects these variables had on their imagination. Imagination in this study referred to the process of transforming the inner imagery of education students, when they were faced an instructional design task.

1.1 Imagination

Imagination enables people to go beyond actual experience and construct alternative possibilities, in which a fragmented situation becomes a meaningful whole (Passmore, 1985). Therefore, imagination can be viewed as the basis for cultivating creative thinking, and thus the driving force of innovation (Finke, 1996). From the related literature, nine capabilities were compiled to represent human imagination. These capabilities were crystallization, effectiveness, elaboration, exploration, intuition, novelty, productivity, sensibility, and transformation (Cartwright & Noone, 2006; Folkmann, 2011; Liang, Chang, Chang, & Lin, 2012).

First, imagination connects "abstract properties" and "concrete universals" by the law of association, allowing us to set aside familiar distinctions and definitions (Greene, 2000, p. 3). Vygotsky (2004) also believed that all objects of common life appear as a *crystallization* of the imagination. Second, every invention is the result of a particular human need, for its own special purpose. Reiner and Gilbert (2000) confirmed that imagination is goal-oriented, based on prior experiential imagery, which needs to be examined by its *effectiveness*. Third, during the beginning of imagination, an individual's attention is spontaneous, natural, and effortless. As the process continues, imagination becomes a long, detailed, and laborious personal moment (Ribot, 1906). Cartwright and Noone (2006) explained that imagination is what occurs as a person encounters new ideas and engages in confrontations with arguments and controversies. This is an experience of *elaboration.*

Fourth, imagination consists of the possibility of creation as a qualitative leap, which allows one to *explore*, dare, and challenge institutional order, and thus overcome limits (Colello, 2007). Fifth, Reichling (1990) contended that knowledge is gained directly as an insight or a grasp of the whole through *intuition*. Townsend (2003) anchored that if people utilize more intuitive representations, then their imagination would last longer. Sixth, the Platonic philosophy has associated imagination with *novelty*, creativity, and irrationality. Vygotsky (2004) also held that although imagination builds using materials supplied by reality, its products arise from using combinations of concepts that are more removed from reality.

Seventh, imagination corresponds to four particular sets of conditions namely: quantity of images; quantity and intensity of images; quantity, intensity and duration of images; as well as complete systematization (Ribot, 1906). All of these evolving conditions are related to physical dimensions of imaginative *productivity*, continuity and fluency. Eighth, Ribot (1906) held that the essential element of imagination in the intellectual sphere is the capacity of thinking through analogies. The core principle behind analogy is *transformation*. Vygotsky (1978) stressed that this transformation enables children to learn how to control a situation through the use of symbols. Finally, inventors strive to achieve their goals and overcome problems, often experiencing painful struggles in thoughts, feelings, and emotions during creative activity (Ricoeur, 1978). Reichling (1990) also confirmed that feeling is assigned a cognitive dimension, in terms of imagination. *Sensibility* is thus identified as another important characteristic of imagination.

In addition, Fettes (2010) in his recent work identified eight functional capabilities of imagination, which included: grasping regularity, grasping detail, grasping composition, grasping wholes, grasping possibility, grasping struggle, grasping indices, and grasping inconsistency. Fettes categorized these imaginative capabilities into three groups. The first three capabilities might be thought of as grasping the coherence and stability of the world; the second three capabilities emphasized change, variation, and unpredictability; and the last group of two emphasized the role of integration.

1.2 Influential variables on imagination stimulation

Research has shown that the environment can facilitate, modify or hinder certain human behaviours and emotions (e.g. Strange & Banning, 2001). Accordingly, the campus environment can be divided into four dimensions: physical component, organizational measure, social climate, and human aggregate (American College Personnel Association, 1994). The *physical component* dimension of a campus consists of its natural environment (geographic location, topography, temperature, etc.) and man-made environment (architecture, sound, facilities, and messages sent to its inhabitants). Both components define space for activities and events, thereby encouraging some phenomena while limiting others (Strange, 2000). There are numerous follow-up studies which indicate that the environment has a profound impact on students' imagination (e.g. Büscher, Eriksen, Kristensen, & Mogensen, 2004; Claxton, Edwards, & Scale-Constantinou, 2006).

The *organizational measure* dimension arises from the myriad decisions made about environmental purposes and functions (Strange, 2000). Who is in charge? How will resources be

distributed? What must be accomplished and how quickly? How will participants be rewarded for their accomplishments? As a result of this need, rules and regulations are formed, rewards systems are developed, and reports become necessary for resource allocation. Such organizational measures could raise or lower the morale of participants. Many studies by modern scholars (e.g. Claxton et al., 2006; Kangas, 2010) also give evidence as to the influence of organizational measures on students' imagination development.

The *social climate* dimension focuses on the subjective experiences of participants (Strange et al., 2001). Social climate has both intrinsic influence and external impact. McMillan (1995) thus held that all schools should create a context that is full of encouragement and support in order to cultivate students' imagination. Moreover, the *human aggregate* dimension represents the collective characteristics of people who inhabit the environment. This dimension creates features in an environment that reflect varying degrees of consistency, especially in terms of organizational culture, tradition or style (Huebner et al., 1990). Modern research (e.g. Claxton et al., 2006; Treadaway, 2009) also echoes the impacts of socially constructed and human aggregate dimensions on an individual's imagination.

In addition, human imagination will also be stimulated by psychological sources such as motivation, emotion and cognition (Byrne, 2007). According to Rosenbaum (2002), people's performance at a given time is influenced by what they imagine and plan to do next. Such anticipatory effects have been treated as clues to the nature of human perceptual-motor planning. Oettingen and Mayer (2002) also indicated that positive expectations would predict high-effort and successful performance. This form of thinking about the future is closely related to *motivation*.

Fredrickson (2001) suggested that *emotions* such as joy and love broaden a person's available repertoire of cognitions, thus enhancing creativity and imagination. Although emotions have been studied as facilitating variables in changing people's attitude, creativity and problem-solving skills (e.g. Erez & Isen, 2002), there are conflicting studies however, that argue conversely. For example, emotions experienced during learning processing can be viewed as an unnecessary load on working memory, and it can have a negative effect on reasoning (e.g. Paas et al., 2003).

Many studies indicated that individuals with high *self-efficacy* perceive themselves as capable of taking the necessary steps to resolve problems (e.g. Bandura, 2000). They believe and imagine that they can affect change, and have control over their thoughts and actions. They are confident in their capacities, and consider difficult tasks as challenges rather than threats. In addition, they set meaningful goals and strive to achieve them. In short, people with high self-efficacy are confident and imagine themselves able to do it!

Recent studies in the field of creative imagery revealed the *cognitive* structures and processes that are involved in creative thinking and imagination (Finke, 1996). For example, in the geneplore model of creative cognition, Finke claimed that two aspects accounted for creative thinking and imagination, a generative phase where an individual formulates mental representations, and an exploratory phase where those structures are adopted to establish creative ideas. Creative thinking at the generative phase is closely associated with *generative cognition*, while the exploratory phase is associated with *meta-cognition*. Additionally, O'Connor and Aardema (2005) situated imagination

within consciousness complete with its own pre-cognitive, cognitive and meta-cognitive domains. It allows us to realize how "believed-in imaginings" develop and become under some circumstances, "lived-in experiences."

The philosophical framework provided by Vygotsky (1978, 2004) includes not only insightful interpretations about the cognitive tools of mediation, but also the re-interpretation of important concepts in psychology such as the notion of internalization of knowledge. Internalization of acquired knowledge and experience is a crucial way to facilitate imagination (Valett, 1983). Many studies supported that cognitive structures and related tools are closely associated with the learner's perceptions, feelings, motivations and other ways to trigger ideas (e.g. Finke, 1996; Taylor et al., 1998). Thus, *generative cognition* may play a mediating role in stimulated imagination (Finke, 1996; Folkman, 2011; Vygotsky, 2004). Subsequently, the following relationships were hypothesized in this study:

Hypothesis 1. Generative cognition is positively associated with imagination.

Hypothesis 2. Generative cognition mediates the effect of environmental variables and imagination.

Hypothesis 3. Generative cognition mediates the effect of psychological variables and imagination.

Figure 1 summarizes the three sets of variables examined in the present study and their hypothesized relationships with respect to imagination.
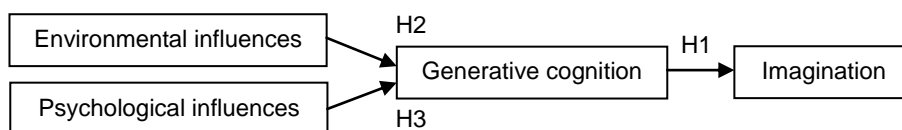

Figure 1. Hypothesized model of the present study

2. Method

2.1 Measures

Imaginative Capability Scale. Based on the research of Liang et al. (2012), the measure for imaginative capability in this study was a 9-item scale. Respondents answered on a five-point scale ranging from 1 = strongly disagree to 5 = strongly agree. Some representative items are: "I am good at seeking improvement by logically analyzing ideas" (Cronbach's α = .86), "I often help myself imagine by arousing personal feelings" (Cronbach's α = .81), and "I often have uncommon ideas compared to others" (Cronbach's α = .83).

Psychological Influence Scale. Based on the study done by Hsu, Huang, and Lin (2012), psychological influences were measured with a 24-item scale which was composed of six subscales namely: intrinsic motivation, generative cognition, emotion, stress, inspiration through action, and self-efficacy. The *generative cognition* is a four-item subscale that measured the degree to which participants considered what cognitive approaches were important in stimulating their imagination.

The *emotion* subscale includes three items reflecting the extent to which participants reported being positively influenced by a feeling. The *stress* subscale is a four-item subscale that indicated the degree to which participants felt their imaginations were influenced by their negative psychological states and surroundings. *Self-efficacy*, a five-item scale, evaluated the extent to which participants reported being influenced by the belief in their own competence. The *intrinsic motivation* subscale consists of four items that assess participants' imagination being influenced by personal satisfaction rather than for some external rewards. Finally, four items constitute the *inspiration through action* subscale and examine how participants felt regarding their imagination being influenced by meta-cognition with hands-on practice. Respondents answered on a five-point scale ranging from 1 = strongly disagree to 5 = strongly agree. Some representative items from this scale are: "Use immersive sensory exploration to spark imagination" (generative cognition, Cronbach's α .73), "Joyfulness from the surroundings" (emotion, Cronbach's α .81), "Anxiety felt by individuals" (stress, Cronbach's α .85), "Be determined to achieve set standards" (self-efficacy, Cronbach's α .85), "Courage to present different ideas" (intrinsic motivation, Cronbach's α .84), and "Hands-on design with constantly-changing concepts envisaged in mind" (inspiration through action, Cronbach's α .81).

Environmental Influence Scale. Based on the study of Liang, Chen, and Huang (2012), environmental influences were measured with a 19-item scale which was composed of four subscales namely: social climate, physical component, organizational measure, and human aggregate. The *social climate* subscale consists of seven items that assess the extent to which participants reported being influenced by the climate of the class. The *physical component* subscale includes four items reflecting the degree to which participants felt the facilities and messages in an environment stimulated their imagination. The *organizational measure* subscale is a five-item subscale that measures participant perception of the influence of organizational structure and instructional measures. Finally, three items constitute the *human aggregate* subscale. It reflects the extent that the imagination is influenced by the organizational culture and its dominant human characteristics by the participants. Respondents answered on a five-point scale ranging from 1 = strongly disagree to 5 = strongly agree. Some representative items from the survey are: "Communication and discussion with classmates" (social climate, Cronbach's α .87), "Public spaces for creation, discussion and exhibitions" (physical component, Cronbach's α .72), "Teacher's encouragement and praise for taking risks" (organizational measure, Cronbach's α .83), and "There is a culture on campus of putting imagination into practice" (human aggregate, Cronbach's α .80).

2.2 Participants, procedure and analyses

The participants in this study were two samples of students from eight education programs across different regions in Taiwan. Sample one (*n* = 402) served as the calibration sample for testing the appropriate structures of the imaginative capabilities, psychological influence, and environmental influence using exploratory factor analysis. Sample two (*n* = 380) served as the validation sample using confirmatory factor analysis for validating the factor structure from sample one, and establishing the predictive model. Of the participants of sample one, 250 of 402 were

female (62%). The dominant grade groups were sophomores (29%) and graduate students (29%). In sample two, 286 of 380 were female (75%). The majority of grade group was also sophomores (24%).

In the questionnaire, students were asked to determine the level of agreement with regard to each imaginative capability, and the strength of influence that each item of psychological/environmental influence had on their imagination. Data collection of each survey was conducted by graduate assistants who were accompanied by the class instructor. All the assistants were graduate students in the video/film programs. Each of them received 18-hour training in order to ensure the quality of investigation.

In order to ensure the quality of this study, the research team discussed the survey content with instructors in the target programs first, and then arranged similar assignments and schedules. Therefore, this study could be implemented across campuses under a comparable timetable and similar design tasks. The investigation process delivered in each program followed the same procedure. The participants were guaranteed anonymity, confidentiality, and the right to review the results of their responses.

3. Results

3.1 Principal component analysis and confirmatory factor analysis

Both principal component analysis (PCA) with promax-rotation and confirmatory factor analysis (CFA) with maximum likelihood estimator were conducted to determine the most appropriate structure of the developed scales. The number of factors to be extracted for these analyses was determined using a number of criteria which include: eigenvalues above 1.0 (Kaiser, 1960), examination of Cattell's scree test (Cattell, 1966), communality values greater than .30, and the total variance accounted for by each factor. Based on these criteria, in the sample one, data was analyzed using SPSS version 17.0 software. The single-factor solution of *imagination* (explained variables of 33.27%) with an oblique rotation provided a good factor structure both conceptually and statistically. Our results also showed that the internal consistency of imagination (.81) was considered stable.

In the sample two, CFA was performed with LISREL 8.80 to further test the factor structure. We used the indicators recommended by Hu and Bentler (1999) and Tabachnick and Fidell (2001) to assess goodness of model fit: Comparative Fit Index (CFI; .95 or above indicating excellent fit, .90-.95 indicating an acceptable fit), Root-Mean-Square Error of Approximation (RMSEA; .05 or below indicating excellent fit, .05-.08 indicating an acceptable fit), Standardized Root Mean Squared Residual (SRMR; .05 or below indicating excellent fit, .05-.08 indicating an acceptable fit), Tucker-Lewis Index (TLI; .95 or above indicating excellent fit, .90-.95 indicating an acceptable fit). In regards to the imaginative capability, the single-factor solution yielded acceptable fit for this study ($X^2 = 135.89$, *df* = 27, p < .005, CFI = .94, RMSEA = .08, SRMR = .06, TLI = .92) with a construct reliability of .84 (refer to Table 1).

Table 1. Descriptive statistics and factor loading of the imagination

Characteristic	Item	Sample 1		Sample 2	
		M	*SD*	PCA	CFA
Productivity	I constantly have ideas toward my designs	3.27	.80	.73	.75
Transformation	I am flexible in my thinking and can transfer ideas to multiple fields of tasks	3.55	.76	.67	.62
Sensibility	I often help myself imagine by arousing personal feelings	3.70	.73	.63	.72
Intuition	I often come up with new ideas leading by my intuition	3.78	.76	.60	.68
Novelty	I often have uncommon ideas compared to others	3.21	.78	.57	.65
Exploration	I like to explore unknown areas of knowledge and experience	3.92	.69	.57	.60
Effectiveness	I often complete my tasks by focusing on effective ideas	3.57	.71	.52	.44
Crystallization	I am good at expressing abstract ideas by using concrete examples	3.50	.81	.46	.56
Elaboration	I improve my thoughts by focusing on formalizing ideas	3.44	.82	.37	.37

In regards to *psychological influences* for the sample one, the PCA extracted six factors with eigenvalues greater than one, explaining 56.49% of the cumulative variances. These six indicators were: *intrinsic motivation* ($M = 4.09$, $SD = .54$), *self-efficacy* ($M = 3.91$, $SD = .57$), *stress* ($M = 3.63$, $SD = .69$), *inspiration through action* ($M = 3.92$, $SD = .53$), *emotion* ($M = 4.06$, $SD = .61$), and *generative cognition* ($M = 3.90$, $SD = .50$). Our results also indicated that the internal consistency of psychological influences (.87) was considered stable.

In the sample two, the results of CFA showed a good fit to match the hypothesis that six psychology-related factors influence imagination, $X^2(237) = 711.91$; CFI = .97, RMSEA = .07, SRMR = .06, TLI = .96. The factor loadings of items on the subscale of *intrinsic motivation* ranged from .70 to .77 (with a construct reliability of .82), those of *self-efficacy* from .69 to .78 (with a construct reliability of .86), those of *stress* from .62 to .85 (with a construct reliability of .84), those of inspiration through action from .58 to .81 (with a construct reliability of .81), those of *emotion* from .55 to .91 (with a construct reliability of .82), and those of *generative cognition* from .53 to .67 (with a construct reliability of .72).

With respect to *environmental influences* for the sample one, the PCA extracted four factors with eigenvalues greater than one, explaining 50.05% of the cumulative variances. These four indicators were: *social climate* ($M = 4.04$, $SD = .54$), *physical component* ($M = 3.55$, $SD = .48$), *organizational measure* ($M = 3.99$, $SD = .51$), and *human aggregate* ($M = 3.91$, $SD = .67$). Our results also indicated that the internal consistency of environmental influences (.89) was considered stable.

In the sample two, the results of CFA showed a good fit to match the hypothesis that four environment-related factors influence imagination, $X^2(146) = 514.40$; CFI = .96, RMSEA = .08, SRMR = .06, TLI = .96. The factor loadings of items on the subscale of *social climate* ranged from .46 to .75 (with a construct reliability of .85), those of *physical component* from .59 to .63 (with a construct reliability of .71), those of *organizational measure* from .63 to .76 (with a construct reliability of .82), and those of *human aggregate* from .67 to .81 (with a construct reliability of .78).

3.2 Correlations

The relationship between the influential variables and imagination was continually examined. The team found that the averaged correlation coefficient is .28, and the individual coefficients are between .15 and .44. The results also indicated that the influential variables were significantly correlated, p < 0.05. The averaged correlation coefficient of the influential variables is .66, and the individual coefficients are between .39 and .87 (refer to Table 2).

Table 2. The correlation among variables ($n = 380$)

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Imagination	--										
2. Intrinsic motivation	0.27[*]	--									
3. Self-efficacy	0.25[*]	0.65[*]	--								
4. Stress	0.15[*]	0.40[*]	0.53[*]	--							
5. Inspiration through action	0.29[*]	0.78[*]	0.72[*]	0.39[*]	--						
6. Emotion	0.25[*]	0.68[*]	0.61[*]	0.39[*]	0.59[*]	--					
7. Generative cognition	0.44[*]	0.82[*]	0.68[*]	0.44[*]	0.67[*]	0.69[*]	--				
8. Social climate	0.29[*]	0.71[*]	0.66[*]	0.53[*]	0.66[*]	0.67[*]	0.73[*]	--			
9. Organizational measure	0.32[*]	0.72[*]	0.61[*]	0.44[*]	0.64[*]	0.57[*]	0.73[*]	0.87[*]	--		
10. Human aggregate	0.23[*]	0.68[*]	0.68[*]	0.50[*]	0.64[*]	0.57[*]	0.65[*]	0.74[*]	0.73[*]	--	
11. Physical component	0.27[*]	0.66[*]	0.63[*]	0.47[*]	0.57[*]	0.54[*]	0.67[*]	0.72[*]	0.77[*]	0.68[*]	--

*$p < .05$.

3.3 Structural model and hypothesis testing

The present hypotheses suggest that three sets of variables (*generative cognition, environmental variables*, and *psychological variables*) influence imagination, and that *generative cognition* mediates the effects of the other two clusters of variables on imagination. According to these hypotheses, the research team using data of the sample two, first proposed a *full mediation* model. In this model, all the variables would enhance *generative cognition*, and generative cognition, in turn, would fully mediate the influence of these variables on imagination. We also wanted to compare the full mediation model with a model that is more consistent with the idea that some of the variables may continue to enhance imagination after controlling for the influence that such effects have on generative cognition. Therefore, in the *partial mediation* model, we predicted that all the influential variables would have both direct and indirect effects on the student imagination (refer to Figure 2).
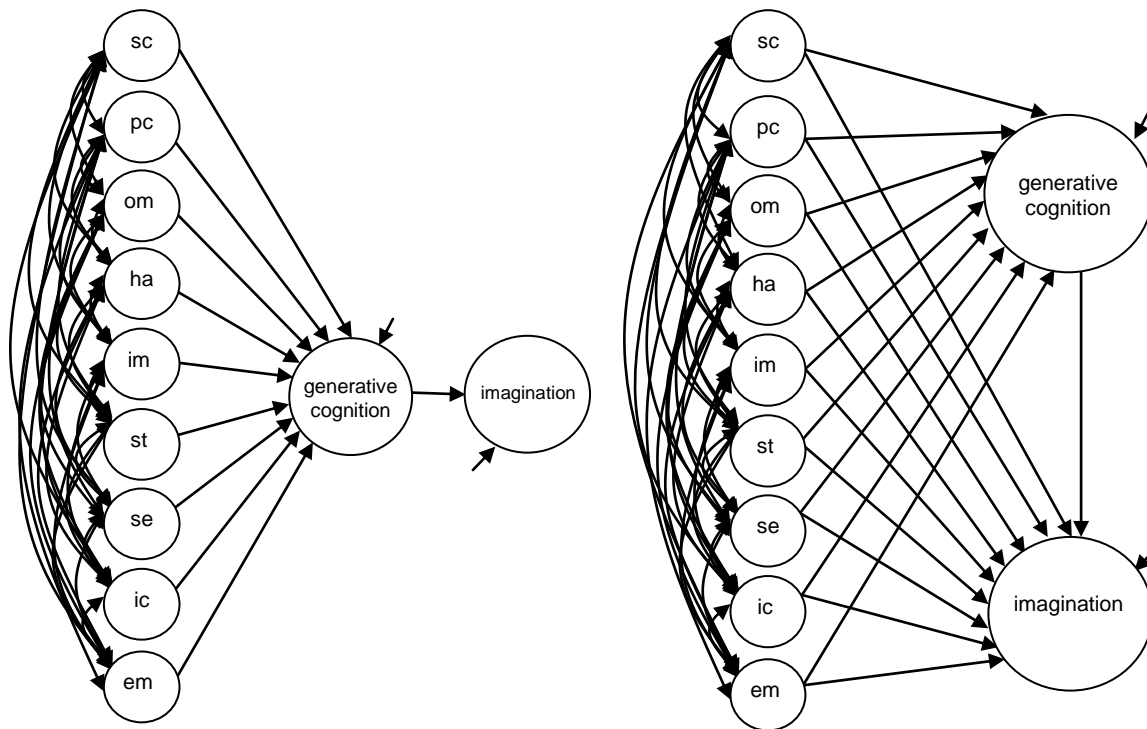
Figure 2. The full mediation model (left) and partial mediation model (right) in the present study.

Note: Environmental influences: social climate (sc), physical component (pc), organizational measure (om), human aggregate (ha); psychological influences: intrinsic motivation (im), stress (st), self-efficacy (se), inspiration through action (ic), and emotion (em).

Both of the full mediation model (X^2 = 2679.55, df = 1228, CFI = .97, RMSEA = .06, SRMR = .06, TLI = .97) and partial mediation model (X^2 = 2671.17, df = 1219, CFI = .96, RMSEA = .06, SRMR = .05, TLI = .96) showed a good fit to the present data. The chi-square difference test between these two models showed no significance. Since the full mediation model is more simplified and more presentable, the team decided to adapt it and continually made necessary modifications.

In the full mediation model, however, due to a high correlation between some of the variables, neither all were significantly associated with imagination. Taking into account the multicollinearity and the low standardized path coefficients, the less significant paths were removed. In the revised model, only the four paths respectively, *organizational measure*, *intrinsic motivation*, *emotion*, and *self-efficacy* to the mediator (*generative cognition*) were kept.

This revised model showed a model fit comparable to that of the initial model, X^2 = 922.70, df = 394, CFI = .96, RMSEA = .06, SRMR = .06, TLI = .96. Furthermore, it accounted for substantial variance in both generative cognition (R^2 = .73) and imagination (R^2 = .17). The standardized path coefficient of *generative cognition* reached .41*, and the path of *intrinsic motivation* reached .40*, followed by the path of *organizational measure* .25*, *emotion* .17*, and *self-efficacy* .16*. In the case of model trimming, a significant chi-squared goodness of fit test ($\Delta\chi^2$ =1756.85, Δdf=834, p < 0.05) suggests that the revised model is a more suitable fit to the data than the initial, full mediation

model, and hence, should be supported.

Overall, the SEM results summarized in Figure 3 support the present hypotheses. *Generative cognition* directly influenced imagination (Hypothesis 1 was supported). Partially supporting the mediating hypotheses (Hypothesis 2 and 3), one environmental variable (*organizational measure*) and three psychological variables (*intrinsic motivation*, *emotion*, and *self-efficacy*) influenced imagination through their impacts on generative cognition.
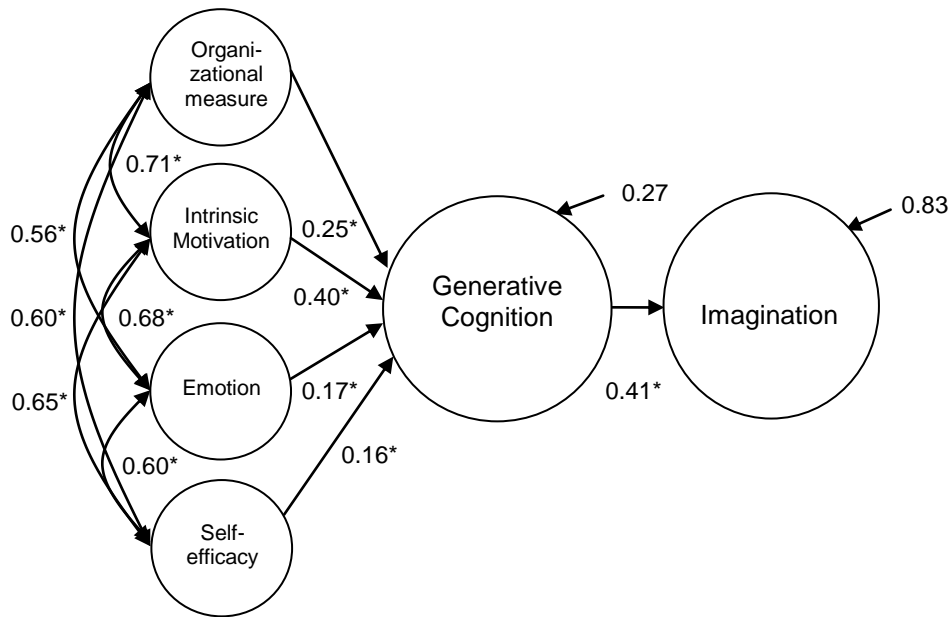

Figure 3. Structural model depicting cognitive generation as mediator of influential variables and imagination.

4. Discussion

This study examined what psychological and environmental variables influence the imagination of education students. In addition, it was assessed to what degree these influences had on student imagination. While philosophical studies abound on the influence of diverse variables on imagination-stimulation, little articulates about imaginative capabilities, nor the variables that may mediate this relationship. Given this observed gap in the literature, the results of this study increase the understanding of the indirect paths from psychological and environmental variables to imagination. The present study especially contributes to the understanding of *generative cognition* as mechanisms through which psychological and environmental states might affect our student imagination.

The results of this study supported that human imagination consists of the nine capabilities: productivity, transformation, sensibility, intuition, novelty, exploration, effectiveness, crystallization, and elaboration. In no way definitive or exhaustive, nonetheless, it has yielded a path for further inquiries. One consideration to bear in mind is whether these imaginative capabilities can be categorized as being easier to be manipulated? This emerged consideration is based upon Betts's (1916) belief that any activity of human imagination can be classified into reproductive imagination and creative imagination. In other words, how can these capabilities to be

grouped into these two categories? What psychological and environmental variables, in turn, have more or less effects on these two types of imagination respectively, and how do they work? On the basis of the definition of these two categories, the authors would propose two hypotheses for testing. First, the capabilities of novelty, productivity, sensibility, intuition and exploration could be categorized as creative imagination. Second, effectiveness, elaboration, crystallization and transformation could be categorized as reproductive imagination. All of these interesting issues and proposed hypotheses grant further research.

Despite numerous studies of meta-cognition and stress influencing human cognition (e.g., O'Connor et al., 2005; Paas et al., 2003), these variables did not play significant roles to predict *generative cognition* in the present study. In other words, the effects of these two variables were less than the effects yielded from other variables such as *intrinsic motivation, self-efficacy*, and *emotion*. This result may suggest that interesting tasks, free discussions and joyfulness from the surroundings should be embedded in learning activities in order to trigger the student imagination. This also suggests that strengthening student self-confidence and work-related efficacy may facilitate his or her imagination.

According to our findings, the environmental influences on imagination are composed of four variables, namely *social climate*, *organizational measure*, *human aggregate*, and *physical component*. Of interest, only *organizational measure* was a significant predictor of *generative cognition*. This suggests the possibility that the effect of organizational measures with respect to a person's cognitive approaches is greater than the effects of other environmental variables. This interpretation corresponds to the research regarding imagination-stimulation through instructional strategies and rewards systems (Claxton et al., 2006; Kangas, 2010). Thus, to improve the student imagination, it may be important to widen teacher capacity of tolerance and diversify his or her ways of encouragement.

Although our results supported the mediating role of *generative cognition* in the current study, we wonder if any other mediator, or if any moderator exists? Are there any non-linear relationships existing among the variables discussed in the present study? Much work needs to be done in order to shed light on these issues. In addition, the structural model showed that *organizational measure, intrinsic motivation, emotion*, and *self-efficacy* have indirect effects on imagination. In other words, no amount of organizational measures, driving motives and self confidence will stimulate learners' imagination, unless students use their cognitive tools. This model implies that researchers and instructors may need to focus less on the indirect and insignificant effects, and more on understanding the direct effects of cognitive tools.

In drawing these conclusions, it is necessary to acknowledge the limitations of this study. First, the final model fits the data well, but the predictive validity could be stronger. This result may be due to the high correlations between some of the variables. Another inference similar to multiple influential variables on human creativity (Shalley, Zhou, and Oldham, 2004), is that both psychological and environmental influences are only but two variables stimulating student imagination. Additional variables, such as learner personality and cultural diversity, should be taken into account for further inquiry. A second limitation is the use of self-reported influence rather than

relying on expert evaluations or behavioral measures. The choice to use self-reports however, was justified by the preliminary nature of the study. There was a lack of existing measures and the questions asked in our study did not include sensitive items that may cause respondents to present themselves in a socially acceptable manner.

Although the limitations of this study must be kept in mind, the results reported here provide intriguing insights into the complexities of imagination-stimulation. The model proposed in this study is significant to the education profession, even to other diverse domains. For example, it would be interesting to elaborate each of the ten imaginative capabilities identified in this study and clarify their uses. It would also be valuable to explore which imaginative capability may be best facilitated in which age-range. It would be even more exciting to elucidate which imaginative capabilities may be required in various domains, e.g., arts, science, design, engineering, or management. Preliminary work such as this always raises a battery of issues and questions. Nevertheless, a great deal of research needs to be further conducted in this area. We sincerely invite you to use the results of this study as a foundation to develop meaningful research projects. We also wish that the utilization of this study will in turn, inspire the construction of appropriate instructional strategies to assist students and develop their imagination.

Acknowledgments

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Extracting Cross-Domain Employability Indicators of E-Business Printing Industry in Taiwan

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Abstract

The research aims at professionals serving with Taiwan's current 1,000 printing businesses in an attempt to extract cross-domain employability of E-Business that the printing industry professional indicators should have in Taiwan. The pilot study aims at confirming and developing a questionnaire based on indicator of employability on E-Business in Printing Industry and the researchers designed Analytical Hierarchy Process (AHP) questionnaire and built its weight to present the cross-domain employability indicators related to E-Business. The research found that the eight main indicators are in the following order by importance: work attitude, teamwork, business operation ability, production/manufacturing ability, pre-press network integration ability, innovation ability, image-processing ability, and editing/design ability. The contribution can benefit the printing industry when recruiting new employee, and to serve as reference for the printing related departments in higher education.

Keyword: Employability, E-Business, Printing industry, Cross-domain, AHP

1. Introduction

The success of a country's economic development depends on whether it can successfully integrate into corporate production systems its labor force with knowledge and ability (McGINN, 1999), and it is even more so for Taiwan's printing industry. Nowadays the scope of publishing has expanded, not just printed resources, but also electronic resources (Hatane, Santoso, & Gorjian, 2011). Human resource quality is an important factor in determining a company's competitiveness, and Levin (2005) believes that fierce competition in dynamic environments, budget reduction and heavy price pressure make business operation highly dependent on high-quality human resources. Rae (2007) also considered that high-quality labor force is required to have cross-domain employability, which is what a mature industry relies on for enterprise transformation and development. Crossan and Berdrov (2003) pointed out that one of the consequences of intense competition, globalization and the advanced development of science and technology is that organizational learning, knowledge creation and innovation capability have combined to form a major benefit supporting corporate competitiveness. It is therefore quite natural that, out of necessity arising from competition, companies have adopted the competence-based perspective and require the employees they recruit to possess cross-domain multiple competences instead of one

single specialized skill. Enterprises tend more and more to require their employees to possess what is needed for business operation in terms of cross-domain competences and the corresponding performance requirements in order for them to remain employed on a long-term basis in the enterprise and to subsequently develop their individual professional careers (Shahin & Mahbod, 2007).

Education is the main means of enhancing Taiwan college students' employability (Wu, 2009). Hillage and Pollard (1998) defined the term "employability" as the capability to move self-sufficiently within the labor market to realize potential through sustainable employment, and considered that if an employee has self-perceived employability, he will be able to deploy employability frequently both within and outside of the enterprise. Rothwell and Arnold (2007) started from the perspective of personal employment and career development to consider that employability is about people's ability to possess skills, find work, and maintain work of the kind they want. For an enterprise, employability means possessing human resources with long-term working ability. The concept of employability can be considered by a corporate organization as employees' long-term working ability, as in the idea of "work for the sake of life" (Pascale, 1995; Rajan, 1997). Kiran, Valli, and Chandulal (2011) indicated that the competency based approach can give rise to a concept which could be called as competent teacher for a competent student. Sanders and de Grip (2004) stated that training participation and task flexibility of low-skill workers in an enterprise are positive and beneficial to their employability within the enterprise and the possibility of their deploying lifetime employability outside of the enterprise. The core professional competencies and the exit profiles should be based on the guiding principles of development (Kiran, Valli, & Chandulal, 2011). All these studies focused on employability are based on the competence-based theory (Ljungquist, 2007). The need to enhance employees' possession of the kind of employability their enterprise demands sustains the inevitability for the enterprise to plan and implement education and training programs. In view of all the above and for the purpose of our study, we can define employability, in the labor market related to the printing industry, as the ability to execute the requirements of the related professional technology cluster and to remain employed on a long-term basis, particularly in E-Business. Dhillon and Kaur (2012) believed that the driving forces of E-Business are changing the very definitions of the core values within many organizations.

It would be highly meaningful to identify the requirements of Taiwan's printing businesses in terms of employees' employability in E-Business and to use the findings as a basis for talent cultivation in higher education. Therefore, based on the research background described above, this study aims at introducing, from a competence-based perspective, a set of indicators for the kind of cross-domain employability required for Taiwan's printing industry professionals. These indicators can then be used as assessment tools by printing businesses in the development of their talent recruitment strategy including the field of E-Business and as a basis for the curriculum planning of related departments in science and technology universities.

2. Cross-domain employability from a competence-based perspective

Printing is one of the industries with a high cluster effect. The production chain going from the upstream supply of raw materials like paper, ink or plastic material, to the actual printing process with pre-press, on-press and post-press technologies, via the various tasks of image process, network transmission, color control and management, printing skill process, gravure printing process and binding process, forms an industry displaying a cluster effect (New Zealand Qualifications Authority [NZQA], 2012).

Information and communication technology have much implications for the organization, operation, and management of printing activities. These ranges were digitally designing and printing processes from digital pre-press to post-press activities. Moreover, conventional printing technologies are facing unceasingly changes with digital technologies and services, such as ERP scheduling or electronic job services and B2C devices.

Treese and Stewart (1998) think that the use of the global internet for purchase and sale of goods and services, including service and support after the sale. Taiwan's printing industry, like in other countries, is characterized by its status as both an industry and a service; its technical content covers knowledge and applications of a broad range of fields, including electronics, mechanics, materials, mathematics, physics, chemistry, optics, chromatics, business estimating, cost analysis, industrial management, production management, art and culture, creative design, multimedia technology, etc. Strader and Shaw (1997) pointed out that modern business methodology that addresses the needs of organizations, merchants, and consumers to cut costs while improving the quality of goods and services, and increasing the speed of service deliver. The production process is highly oriented toward client needs, and the fact that the products tend to be small in quantity but highly diverse and customized means that professionals need to have cross-domain capabilities consisting in streamlined technical operation applications like estimating, design & editing, image process, color management, remote transmission via the Internet, computer application, job scheduling, printing production, logistics, etc. Due to the technology cluster of the industry, it is necessary for printing professionals to possess specialized skills whose content is constituted by cross-domain competences, so that they can meet competence-based requirements and achieve the kind of work performance required by business owners. The technology cluster involved in such professional employability is schematized in the following Figure 1.
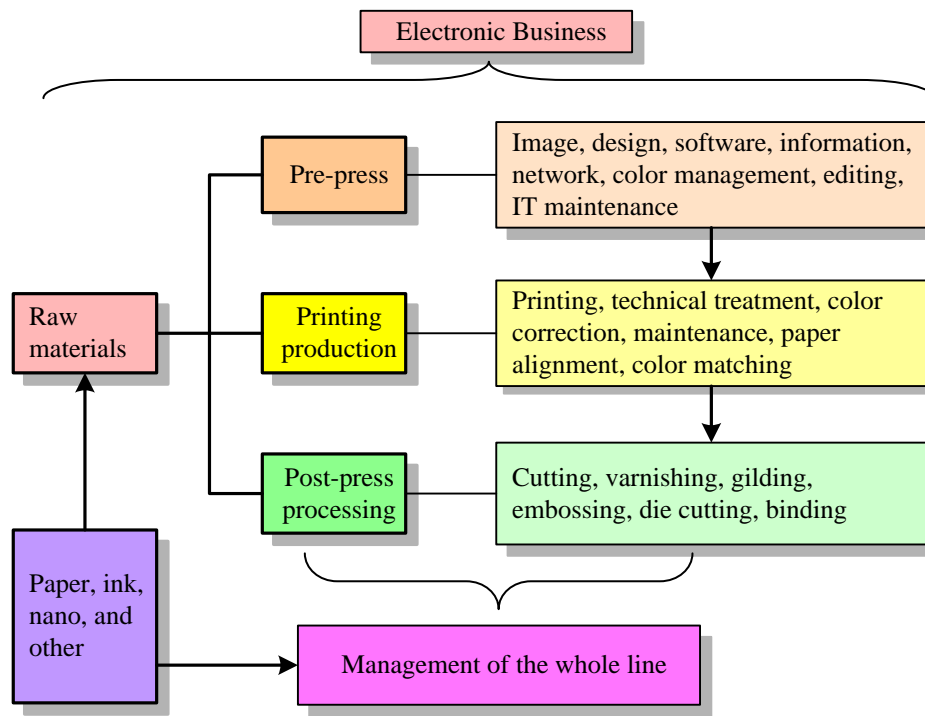
Figure 1. The technology cluster involved in employability for the printing profession

　　Lei and Slocum (1992) deemed that cross-domain competencies involve core competences, professional competencies, management competences, as well as general competences; among them, performance in professional competences is a key factor in corporate competitiveness. As to the cultivation of cross-domain employability, Shahin and Mahbod (2007) considered, from the perspective of organizational performance, that requirements of organizational operation performance can be prioritized in terms of long-term SMART (Specific, Measurable, Attainable, Realistic, Time-sensitive) goal setting. Therefore, cross-domain professional competence implies, for an individual, the possession of the knowledge and skills represented in the technology cluster. In the printing domain, characterized by a technology cluster, the technologies used cover three major areas, and professional knowledge can be divided into three broad domains (Mole, 1997). generic areas of knowledge, generic skills (process knowledge), and generic professional competencies. Competencies are complex and dynamically interactive clusters of integrated knowledge, skills and abilities; behaviors and strategies; attitudes, beliefs, and values; dispositions and personal characteristics; self-perceptions; and motivations (Mentkowski & Associates, 2000). However, in this study, the researchers focused only on the skills, abilities and attitudes of Mentkoski's competencies definition. In general, our study for the concept of competence-based employability is considered as the professional competences required of the professionals employed in the printing industry for the execution of certain professional tasks, and the ability to deploy these competences in their work positions of E-Business, thereby developing their professional careers.

3. Methodology

In this study, a pilot research was first conducted, followed by expert consulting and a formal survey investigation. The purpose of the pilot research was to identify the research issues and the cross-domain employability indicators for professional talent in the printing industry, while the survey investigation aimed to establish weight values for the cross-domain employability indicators related to E-Business. In order to avoid Common Method Variance (CMV), the formal survey by questionnaire was not conducted until one month after the pilot research, the survey questions were randomly sequenced, and respondent identity was concealed (Lin & Peng, 2006).

3.1 Pilot study

In the recent decade, the technological content of Taiwan's printing industry has undergone quantitative and qualitative change, with a high degree of high-tech application in the production flow and a high concentration of knowledge and technology in its products. However, there had been very little research related to the professional competences professionals in the industry are required to have, making it difficult to rely on literature analysis to establish cross-domain employability indicators of E-Business for the printing industry. Therefore, we conducted a pilot research to survey professionals of printing businesses, confirming the importance of the research issues and the feasibility and necessity of the indicators and sub-indicators of cross-domain employability in the printing industry. Following literature review and consulting sessions with experts, and utilized the AHP questionnaire to analyze the weight values for the indicators, the main issues related to the cross-domain employability of E-Business of printing industry professionals were identified, and a draft project for employability indicators was established; based on these elements, a pilot questionnaire was constructed as the research tool for the pilot study. The questionnaire was structured according to the three main dimensions of printing industry, professional personnel, and cross-domain employability. According to Taiwan's printing ecology, there are a few departments are divided in prepress section including design department, editing/image processing department, plate making department etc. All these jobs are inducted to an E-Business environment and the employees are more than on-press, post-press department, hence the returned samplings ratio from prepress section are more than on-press, post-press samplings (see table 1). The sampling targeted Taiwan's 1000 largest printing businesses and 272 questionnaires were randomly sent out, out of which 187 valid ones were recovered, with a recovery rate of 69%.

Table 1. Statistical analysis of recovered questionnaires in the pilot research

Printing departments	Printing personnel	Percentage	N
Pre-press	Design personnel	21.8%	41
	Business personnel	22.3%	42
	Manufacturing personnel	22.7%	42
	Layout/adjustment personnel	19.2%	36
On-press	Press machine operators	9.4%	18
Post-press	Post-processing and binding personnel	4.6%	9
Total		100%	187

3.2 Questionnaire survey

3.2.1   Questionnaire construction

Based on the employability indicators of E-Business expected by printing businesses as shown by the results of the pilot research, an Analytical Hierarchy Process (AHP) survey questionnaire was compiled and then confirmed after discussion with experts, before being used as the tool for the survey investigation.

3.2.2   Administration and recovery

Targeting Taiwan's 500 lithography printing businesses from 1000 largest printing businesses, a random sampling was carried out and on-line questionnaires were sent to selected businesses; printed questionnaires were sent as a complimentary measure to facilitate recovery. A total of 150 questionnaires (each 50 businesses from northern, central and southern Taiwan) were thus administered, with 76 valid returned questionnaires and a recovery rate of 50.67%.

3.2.3   Statistical analysis by AHP

The purpose of the AHP is to analyze the weights of the various indicators of cross-domain employability related to E-Business in order to obtain the weight values for the indicators. Elaborated by Saaty (1971, 1980), AHP is mainly applied in situations of uncertainty and to decision issues involving multiple evaluation criteria. Applied to this study, the AHP used the system's decomposed indicators to make a pairwise comparison of the employability indicators obtained from the pilot research, thereby finding the ratios of relative importance (i.e. weight values) among the indicators. Three steps of AHP methodology for calculating the weights among indicators of different levels is as follows:
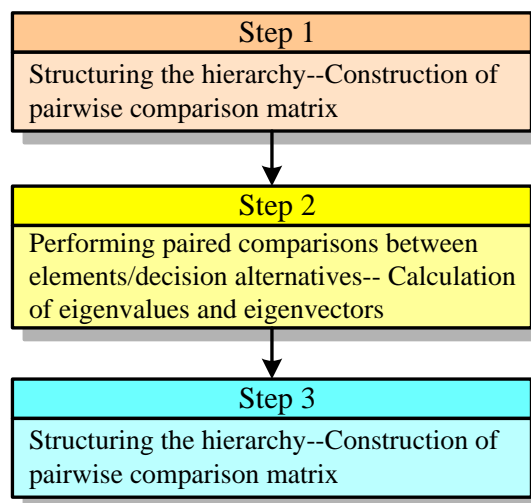
Step 1
Structuring the hierarchy--Construction of pairwise comparison matrix

Step 2
Performing paired comparisons between elements/decision alternatives-- Calculation of eigenvalues and eigenvectors

Step 3
Structuring the hierarchy--Construction of pairwise comparison matrix

Figure 2. Three steps of Analytic Hierarchy Process

3.3 Consistency test

After establishing the pairwise comparison matrix and the whole hierarchy structure, a consistency test must be carried out in order to calculate the Consistency Index (C.I.) and the

Consistency Ratio (C.R.). The closer lamda-max is to n, the more consistent it is. C.I.= (lamda-max – n)/(n-1). If C.I. = 0, it implies that the questionnaire respondent's earlier and later judgments regarding decision factors are consistent. Saaty (1980) suggested using Consistency Index and Consistence Ratio to test the consistency of pairwise comparison matrices. When C.R.≤ 0.1, there is consistency.

A review of the application of the above methodology shows that the execution of the pilot research made it possible for cross-domain employability issues on E-Business investigated in our study to closely match the actual needs of Taiwan's printing industry. The cross-domain employability indicators of E-Business thus obtained were used as the basis for the compilation of the formal survey questionnaire, adding to the objectivity of the content of the questionnaire. Furthermore, in order for the retrieved data to match the needs of the study, after the pilot research was compiled, experts were invited to examine, regarding its content, the correlation between the indicators and the survey questions, so as to make sure the questions truly reflect the content of what was to be investigated. In terms of data analysis, statistics by percentage description was used for the pilot questionnaire, while for the AHP questionnaire, analysis of weight values was carried out by means of the software Excel and Expert Choice 2001.

4. Results and Discussions

4.1　Results of pilot research

4.1.1　The reliability and validity of questionnaire

The overall reliability of the questionnaire was good, with a Cronbach's Alpha coefficient of .914. Regarding the validity, the research contents were revised through three times Delphi Technique by business owners, engineers and department directors in printing companies and the questionnaire also were checked by expert meeting to set up the content validity.

4.1.2　Analysis of survey results of pilot study

The identification and cultivation of professionals' cross-domain employability related to E-Business is an important research issue for the printing industry in present-day Taiwan. The cross-domain employability of printing industry professionals has been obtained by induction and expressed in terms of eight main indicators and 24 sub-indicators as shown in Table 2. The researchers utilized the pretest and three times Delphi method to obtain 8 indicators and 24 sub-indicators. The image-processing ability, pre-press network integration ability, business operation ability, production/manufacturing ability and editing/design ability are related to E-Business, because all these jobs needed to use computers, networks while working in the company all the time. During the last decades, research and development (R&D) activities have become substantial parts of innovation research to explain the innovation ability and competeness of sectors and enterprises (Santamaria, Nieto, & Barge-gil, 2009). The innovation ability becomes the necessity ability in many companies. The teamwork and work attitude belong to the attitudes of Mentkoski's competencies, however all these two abilities are the vital employability in the printing

working environment in Taiwan.

Table 2. Analysis of survey results of pilot study

	Analysis of opinions
Regarding the printing industry	• 90.9% considered the printing industry as a high-tech industry; • 64.2% considered it impossible for the printing industry to be replaced by multimedia and disappear; • 63.6% believed the printing technology must gradually upgrade and transform itself; •38.8% considered the development of professional certification for printing to be of substantial use for production; • 90% believed R&D ability ought to be strengthened; • 83.6% believed that Taiwan's printing technology industry is too small to reach economy of scale for cost reduction.
Regarding the professionals	• 96% believed that the reason printing professionals are not easily available is that school teaching does not match industry needs; • 94.6% found that schools and universities offer too few professional courses in printing related to E-Business, resulting in graduates having difficulties getting connected to the real work and having much less professional know-how than expected by employers; • 76.3% considered the professional skills required for the printing industry are excessively complex and that professionals need to have cross-domain employability; • 92.8% considered the working environment not good enough to attract professionals.
Cross-domain employability (indicators and sub-indicators)	• Image-processing ability (color correction skill, color management, software application); • Innovation ability (innovative design, innovation/R&D, creative application); • Pre-press network integration ability (E-Business, network application, remote transmission, computer maintenance/repair); •Business operation ability (business planning, printing-related foreign language skill, commercial estimating); • Editing/design ability (type/typesetting, multimedia production, aesthetic drawing); • Production/manufacturing ability (printing press machine operation, CTP plate operation, job scheduling); • Work attitude (dedication to work, professional ethics, enthusiasm for learning); • Teamwork (problem-solving ability, communication/coordination ability, ability to react instantly to emergency).

4.1.3 E-Business chains key printing competence-based

In response to the needs of the future development of the printing industry, the professional work areas in which cross-domain employability related to E-Business is required for printing professionals are, by order of importance: screen printing, fast printing, package printing, industrial printing, special printing, cultural printing, and electronic printing. An examination of the

requirements of cross-domain employability for these areas shows the predominance of professional competences, which implies that the respondents still place great importance on the cultivation of professional capabilities, and that they value employees' professional performance, using it as a measure of the value represented by them within corporate organizations. This shows that the competence-based concept is concretely realized in the production activities of printing businesses.

4.1.4 *New path of printing courses in Taiwan printing industry*

The survey results obtained at the level of science and technology universities shows that the courses that may serve to cultivate students' cross-domain employability related to E-Business are, by order of degree of need: general introduction to printing integration, color management, design printing, remote network application, image process, printing production management, innovation/R&D, printing cost estimation and planning, mechanical application, materials application, and information equipment maintenance and repair. There can be positive aspects to this ambiguity, if these students acquire the tools that are needed to continue to learn (Baily, 2002), and have not shut off too many possible paths by their failure to decide and prepare.

It can be observed that courses related to professional areas like planning, design, production, management, application, maintenance/repair, and innovation/R&D are of concrete needs to Taiwan's printing industry. However, "education for all" does not equal "employment for all" (Palmer, 2007) and the issue of how to further match classroom courses with the competences required for cross-domain employability so as to optimize course planning and design will be another important research area.

4.2 Results of pilot research and AHP analysis

4.2.1. *Description of samples*

Among the valid recovered samples, males represented 69.7%, far above the female percentage of 30.3%. The 31- to 50-years old represented the largest age group. As to the category of printing services, those belonging to industries related to printing came out at the top with a whopping 78.9%. The other most represented groups are: in terms of job titles, business owners and technical production staff; in terms of seniority, those who have worked for 16-20 years in the industry (the vast majority of all respondents having a seniority of over 3 years); and in terms of business size, those with 21-50 employees. The details are shown in Table 3.

Table 3. Description of samples

		N	Percentage	Accumulated percentage
Age distribution	21-30 years old	15	19.7	19.7
	31-40 years old	24	31.6	51.3
	41-50 years old	24	31.6	82.9
	51-60 years old	9	11.8	94.7
	Above 61 years old	4	5.3	100.0
	Total	76	100.0	
Category of work	Printing-related industries	60	78.9	78.9
	Electronics-related industries	11	14.5	93.4
	Education-related industries	1	1.3	94.7
	Other industries	4	5.3	100.0
	Total	76	100.0	
List of job titles	Person in charge	14	18.4	18.4
	(Vice) General manager	8	10.5	28.9
	(Vice) Manager	6	7.9	36.8
	(Vice) factory director	4	5.3	42.1
	Director (Section chief)	9	11.8	53.9
	Business personnel	8	10.5	64.5
	Technical production personnel	16	21.1	85.5
	General administrative personnel	1	1.3	86.8
	Technology colleges	1	1.3	88.2
	General universities	2	2.6	90.8
	Professional training institutions	6	7.9	98.7
	Others	1	1.3	100.0
	Total	76	100.0	
Seniority distribution	Under 3 years	15	19.7	19.7
	3-5 years	8	10.5	30.2
	6-10 years	13	17.1	47.3
	11-15 years	11	14.5	61.8
	16-20 years	16	21.1	82.9
	Over 20 years	13	17.1	100.0
	Total	76	100.0	

4.2.2. Analysis of the results of the AHP

4.2.2.1 Construction of an AHP pairwise matrix schema

Based on the cross-domain employability indicators of E-Business obtained from the results of the pilot research, an AHP pairwise matrix was constructed (as in Figure 3) to be used as the basis for the compilation of the AHP questionnaire.
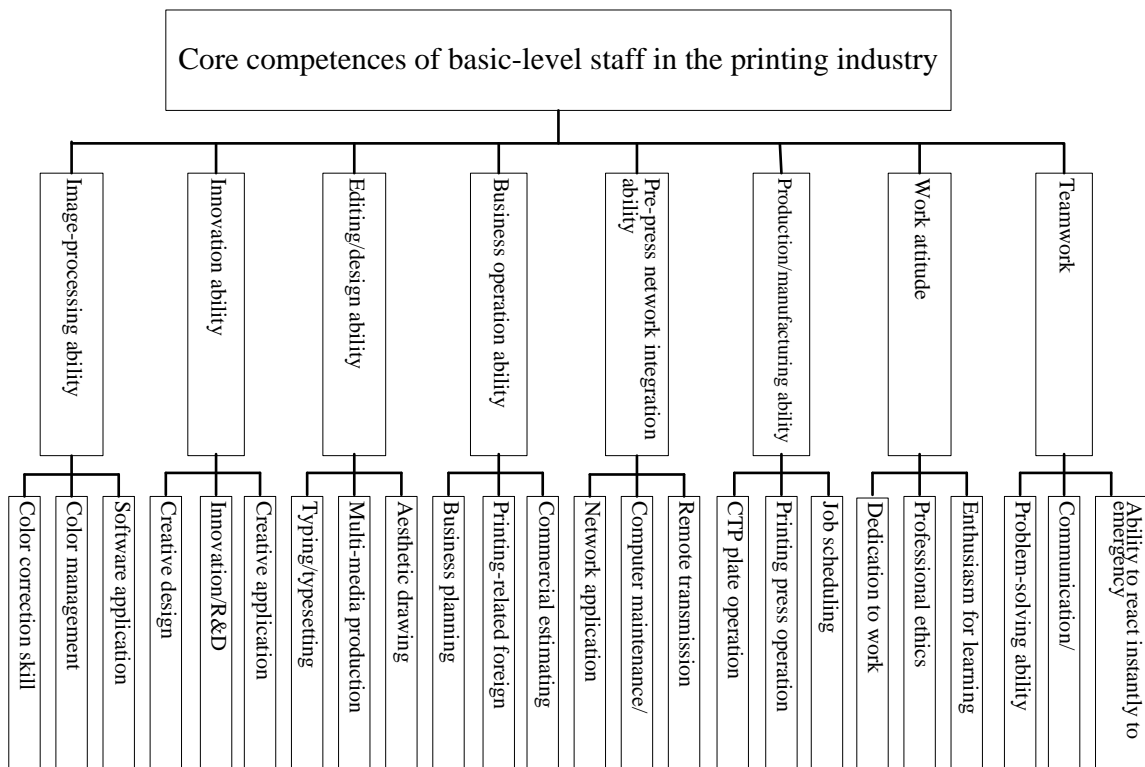
Figure 3. AHP pairwise matrix schema

4.2.2.2 Weights of cross-domain employability indicators related to E-Business

The weights of the indicators are shown in Table 4. The ratio of image-processing ability to innovation ability is 1.02933, and that of innovation ability to image-processing ability is 1/1.02933 =0.97150. Saaty (1971) used the formula of weights (eigenvalue) w can be calculated and turned into %, the values being as follows:

- Image-processing ability (9.690%)
- Innovation ability (9.892%)
- Pre-press network integration ability (10.357%)
- Business operation ability (15.364%)
- Editing/design ability (9.393%)
- Production/manufacturing ability (12.860%)
- Work attitude (16.286%)
- Teamwork (16.157%)

Table 4. Weights of cross-domain employability indicators

	Image-processing ability	Innovation ability	Pre-press network integration ability	Business operation ability	Editing design ability	Production/manufacturing ability	Work attitude	Teamwork	**weight (eigen-value) w**
Image-processing ability	1	1.02933	0.97551	0.63433	1.00427	0.70827	0.57606	0.65004	**0.09690**
Innovation ability	0.97150	1	0.76297	0.70160	1.28396	0.70132	0.61415	0.65884	**0.09892**
Pre-press network integration ability	1.02510	1.31066	1	0.54616	1.41260	0.65486	0.64127	0.59922	**0.10357**
Business operation ability	1.57648	1.42532	1.83098	1	1.95902	1.26704	0.76094	0.82464	**0.15364**

Lamda Max=8.06606　　*C.I*=0.00944　　　*C.R*=0.00674

4.2.2.3 Weights of cross-domain employability sub-indicators which related to E-Business

The weight values of the sub-indicators can be calculated. For example:(see Table 5)

Table 5. Weight values of image-processing ability

	Color correction skill	Color management	Software application	**Weight (eigenvalue)**
Color correction skill	1.00000	0.68009	1.22974	**0.30618**
Color management	1.47040	1.00000	1.66332	**0.43780**
Software application	0.81318	0.60121	1.00000	**0.25602**

Lamda Max=3.00078　　*C.I*=0.00039　　　*C.R*=0.00075

Via a synthesis of the above AHP analyses, the eight main indicators are in the following order by importance: work attitude, teamwork, business operation ability, production/manufacturing ability, pre-press network integration ability, innovation ability, image-processing ability, and editing/design ability. When the total weight value is expressed as 100%, the weights of the various sub-indicators are as shown in Table 6.

Table 6. Weight values of cross-domain employability indicators and sub-indicators related to E-Business

Main indicator	Weight value %	Sub-indicator	weight of sub-indicator %
Image process ability	9.690%	Color correction skill	30.618%
		Color management	43.780%
		Software application	25.602%
Innovation ability	9.892%	Innovative design	31.102%
		Innovation/R&D	27.741%
		Creative application	41.157%
Pre-press network integration ability	10.357%	Network application	34.711%
		Remote transmission	30. 329%
		Computer maintenance/repair	34.960%
Business operation ability	15.364%	Business planning	29.765%
		Printing-related foreign language skill	37.254%
		Commercial estimating	32.981%
Editing & design ability	9.393%	Typing/typesetting	20.534%
		Multi-media production	28.881%
		Aesthetic drawing	50.585%
Production/ manufacturing ability	12.860%	Printing press operation	33.070%
		CTP plating operation	26.530%
		Job scheduling	40.400%
Work attitude	16.286%	Dedication to work	35.765%
		Professional ethics	35.810%
		Enthusiasm for learning	28.425%
Teamwork	16.157%	Problem-solving ability	32.962%
		Communication/ coordination ability	33.392%
		Ability to react instantly to emergency	33.646%

4.3 Printing factory in E-Business Process model

E-business goes far beyond e-commerce or buying and selling over the Internet, and deep into the processes and cultures of an enterprise. It is the powerful business environment that is created when you connect critical business systems directly to customers, employees, vendors, and business partners, using Intranets, Extranets, ecommerce technologies, collaborative applications, and the Web. E-Business or E-Business is Integration of internal and external processes through electronic medium. However, Zwass (1996) believes that electronic commerce (E-commerce) is sharing business information, maintaining business relationships, and conducting business transactions by means of telecommunications networks.

This technology is rapidly changing business in many industries. E-Business is changing the way we do business such as B2B or B2C, in every value chain (initial benefits for manufacturing firms will focus on the supply chain, from procuring raw materials, manufacturing the product to finally distributing products to clients). It shows that all the jobs from sales to production line done in printing works are related to E-Business. The technology of E-Business is different: it is smaller,

faster and much more fragmented. An E-Business infrastructure is made up by piecing together different systems (the first thing that is usually done is linking various E-Business applications, such as an ordering website, into the ERP system, by passing the ERP order entry method and just using the ERP system as a big database of inventory), as shown in figure 4.
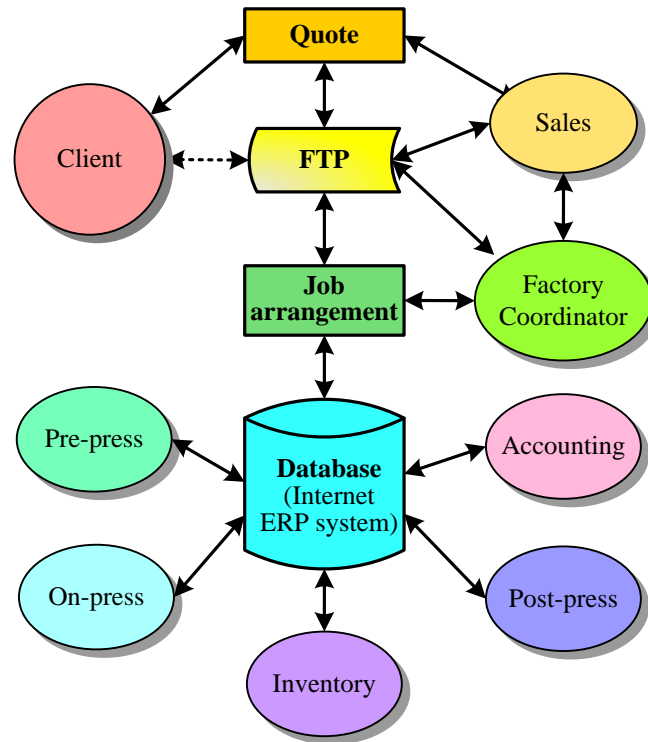

Figure 4. The E-Business model formed and included ERP as an Internet system in printing manufacturing (Figure source: designed by researchers).

The researchers draw this figure 4 based on a complete printers production structure commonly to match the main indicator shown in table 6. There are many divisions which include different employabilities invidually such as the pre-press workers need the image process ability and salesmen need business operation ability and the factory coordinator needs production/manufacturing ability and editing & design ability etc.

5. Conclusions and Suggestions

The investigation of cross-domain employability related to E-Business is highly important for the cultivation of talent for the printing industry in Taiwan. On this issue, this study offers fundamental research results obtained from a pilot research and a formal survey investigation, shedding meaningful light on what Taiwan's hi-tech printing industry needs in terms of professionals' competences in the process of its development. The conclusions of the study can be used for reference purposes by enterprises seeking to recruit new talent, and by science and technology universities in the examination, modification, planning and design of the courses offered in departments related to the printing field in E-Business.

Therefore, this study can make contributions to both the industry and higher education in their

talent cultivation endeavors. However, although the weights of the indicators and sub-indicators of cross-domain employability related to E-Business have been obtained, a gap remains to be bridged between professional competences and course design, and the issue of how to match them is more than relevant when it comes to talent cultivation.

Particularly, over the last ten years the development of Taiwan's information technological industries has been accelerating, and the integration of computer technology in the hi-tech printing industry has been generalized, making cross-domain employability of E-Business especially important. It can be expected that, as the knowledge and technology related to the printing industry evolve rapidly, and Taiwan's printing businesses tend to be small in size, the only way for employees to deploy individual value within businesses is to have their cross-domain employability enhanced.

This study has not been able to cover such issues as the development of professional courses on E-Business in printing, or professional certification that guarantees work efficiency and quality. In view of the fact that the content of the professional technology involved in the printing industry is complex and the need for cross-domain employability related to E-Business is high, and the results are concluded as bellows:

(1) In future curriculum development emphasis can be placed on the elaboration, based on the indicators, of a modular curriculum for each area of professional work, so as to allow students to choose a curriculum centered on the technology cluster of a specific area of professional work determined in accordance with their individual needs and expectations in terms of career development.

(2) Moreover, the spirit of the competence-based approach lies in the fact that in the production activities of an enterprise, the professionals are required to seek production efficiency and quality; and professional certification remains an indispensable element in enhancing not only work efficiency and quality, but above all, personal employability of E-Business.

(3) An important direction for future research consists in using the indicators analyzed in this study to: develop auxiliary tools for corporate talent recruiting, with a view to providing a basis for the objective recruitment of professionals with cross-domain employability of E-Business; examine and amend the assessment criteria for professional certification related to the hi-tech printing industry; and provide emerging countries as a reference for the elaboration and design of competence-based professional modular curricula.

(4) For the most schools of the university of science and technology, to cultivate the students' skills is considered as a very crucial goal in courses. However, not all the skills can be the first choice of the industries. The researchers extracted the cross-domain employability indicators from e-business printing industry to offer the printing business and so as to improve their working division and productivity in Taiwan. On the contrary, the industry preferred the attitudes and teamwork abilities as they believed that these two factors are the company's progress momentum. Therefore, the direction of technical and vocational education should pay high attention to train students' competence not only in acquired skills but in work attitude and team cooperation ability.

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Appendix A

Questionnaire samples

If the left of A"Image process ability"is important than"Innovation ability", please hook the mark on the left side blank depend on the degree of important.

Goal A	Absolutely important	Very important		Important	Slightly important		Equally important		Slightly important		Important	Very important		Absolutely important	Goal B
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1 Image process ability			✔																Innovation ability

High ⟵ The degree of relative important ⟶ High