

C7: 数码学习与人力发展 (Digital Learning and Human Resource Development)

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Mining and Visualizing Domain Knowledge in E-Learning Enabled Workforce Development

Using Co-Occurrence Analysis

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Abstract: *E-Learning is playing an increasingly important role in human resource development, attracting increased attention from researchers and practitioners. Topics on various aspects of E-Learning for workforce development have emerged, showing dynamics of knowledge construction in this area. This study aims to figure out discourse topics and sub-areas of domain knowledge in E-Learning enabled workforce development based on selected academic and industrial journals, magazines, and conferences in this field. A set of methods including co-occurrence analysis, hierarchical cluster analysis, and social network analysis are employed for data analysis. The results figure out a number of key topics in this field and suggest that current domain knowledge in E-Learning enabled workforce development is mainly constructed around three themes: Web-based employee training, Virtual learning community, E-Learning evaluation and delivery.*

Keywords: E-Learning, workforce development, human resource management, co-occurrence analysis

1. Introduction

Along with the proliferation of E-Learning as a kind of medium and a paradigm for knowledge delivery and acquisition in enterprise training programs, examination of E-Learning as a key enabler for human capital development becomes one of emergent topics in research and practice. In organizations, E-Learning is playing an increasingly significant role in workforce development. According to survey data from industries, increasing proportion of managers from big organizations have access to online management and leadership development courses (Scott-Jackson, Edney, & Rushent, 2008), and large proportion of high-growth companies are using learning technologies in their training programs (Howard, 2008). While human is of core value for sustainable development of organizations, launch of E-Learning programs becomes benchmark practices of human recourse development in best-in-class organizations (Martin, 2007), with return-on-investment (ROI) in terms of cost reduction reported for e-learning (Harris, 2003; Deeney, 2003). In academic studies, a variety of research issues have emerged, for example, the importance of human capital development as an indicator for calculating of value of E-Learning (Servage, 2005), potential and effectiveness of E-Learning systems in workforce development and performance support (Allan & Lewis, 2006; Jones & McCann, 2005; Ardichvili, Page, & Wentling, 2002; Benson, 2004), employees or organizational readiness (Watkins, Leigh, & Triner, 2004; Haney, 2002), and management strategies or recommended actions (Murray, 2001; ASTD/NGA, 2001). The diverse research issues and topics have lead to vagueness and complexity in knowledge structure of this field. To establish a better understanding of knowledge structure and feature of e-learning enabled workforce development, this study will figure out discourse topics and sub-domains of current knowledge related to E-Learning and workforce development. The objectives of this study include: 1) to figure out the discourse topics, represented by meaningful keywords and phrases, in the literature; and 2) to identify the sub-domains of current knowledge in E-Learning enabled workforce development.

2. Research Design

This research is in nature an exploratory study. Bibliometric perspective and methodology are employed to implement the research. Two main phases comprise the research process. First, textual data are drawn out directly from literature and transferred to numerical scale. And then a set of data analysis methods including co-occurrence analysis, multivariate analysis, and social network analysis are carried out to discover and visualize meaningful knowledge structure hidden in data.

2.1. Sample

The sample used in this study is consisted of normalized keywords and phrases extracted from subject literature. The sampling process is composed of a sequence of steps given as follow: *a)* sampling of research studies and practitioner articles related to E-Learning and workforce development. First, the Gale database [Academic OneFile](#), ISI Web of Science databases and [EBSCOhost research databases](#) including Academic Search Premier and Business Source Complete are selected as the sampling frame. With “E-Learning” as entry word in the first round retrieval, a set of journals, magazines and conferences related to human resource management are selected as source publications. Names of the source publications are listed in Table 1. A second round retrieval with terms such as “E-Learning”, “virtual” and “electronic” as entry words from the source publications results in a total number of 275 articles. *b)* extraction and normalization of keywords and phrases. To generate a keyword library for co-occurrence analysis, a first step of keywords extraction is implemented. Meaningful keywords and phrases extracted from title and abstract of articles along with subject terms indexed by databases suppliers and keywords provided by authors of articles comprise the raw keyword library. A total number of 640 unique keywords and phrases are extracted. The raw keywords and phrases are then normalized by merging synonyms, hypernym, holonyms and meronyms. As an example of keywords normalization, term “E-Learning/ computer-assisted instruction/ internet in education/ web-based instruction/ distance education” is used to represent following raw keywords: E-Learning, computer-assisted instruction, computer managed instruction, computer-based instruction, computer based learning, internet in education, web-based instruction, web-based learning, distance education, distance learning, online learning, virtual education, and open learning. For normalized term expression, “/” and “//” are used as delimiters, with the former approximately denoting a synonymic relation and the latter signifying a combination. A total number of 125 normalized terms are generated, of which 85 normalized terms with a frequency higher than two are selected as the final sample of co-occurrence analysis.

2.2. Methods and Procedures

To identify main sub-domains of current knowledge in E-Learning enabled workforce development, three main techniques are employed in this study: co-occurrence analysis, hierarchical clustering and social network mapping.

Co-occurrence analysis of keywords is also referred to in literature as co-word analysis (He, 1999), which is a kind of bibliometric technique widely used in scientometrics researches. The basic idea of this method is using statistical techniques such as cluster analysis or factor analysis (Neff & Corleyb, 2009) to exploratorily get groups of keywords which have high co-occurrence frequencies in literature in some subject field, and then using social network analysis technique to map out relationships between keywords and keyword groups. Through the ties between and positions of keywords and keyword groups in the map, core research topics can be easily identified (Ding, Chowdhury, & Foo, 2001). To carry out co-word analysis, four sequential steps are usually implemented by researchers: keywords selection and standardization, co-occurrence matrix construction, clustering, and making

Table 1. Source publications of sample articles

Name of Publications	Articles	Name of Publications	Articles
Industrial & Commercial Training	49	7th European Conference on e-Learning	3
T+D	45	Human Resource Planning	3
Performance Improvement	27	2nd International Conference on e-Learning (ICEL 2007)	2
Journal of Workplace Learning	25	8th IEEE International Conference on Advanced Learning Technologies	2
Team Performance Management	23	Public Personnel Management	2
Performance Improvement Quarterly	18	3rd International Conference on Web Information Systems and Technologies	1
Journal of European Industrial Training	14	6th IASTED International Conference on Web-Based Education	1
Education + Training	11	6th International Conference on Industrial Logistics 2003	1
International Journal of Training & Development	8	6th International Conference on Web Based Learning (ICWL 2007)	1
Human Resource Development International	8	8th International Conference on Industrial Logistics (ICIL 2006)	1
Human Resource Management	6	Workshop on Contemporary Perspectives on Learning for Work	1
Human Relations	6	Management Learning	1
Human Resource Management Review	5	Journal of Managerial Psychology	1
ITI 6th International Conference on Information and Communications Technology	4	Journal of Applied Psychology	1
International Journal of Human Resource Management	4	Educational Technology & Society	1

strategic diagram (e.g. Lee & Jeong, 2008; Neff & Corleyb, 2009). According to literature, Euclidean distance and Ward's algorithm based hierarchical cluster analysis is a widely used method to get keyword clusters in co-word analysis practices (e.g. Ding, Chowdhury, & Foo, 2001; Lee & Jeong, 2008). Ward's method is also named minimum variance cluster analysis, which is a kind of agglomerative algorithm seeking to minimize with-in cluster variance (Punj & Stewart, 1983). With dendrogram produced by hierarchical cluster analysis, number of keyword clusters and components of each cluster can be clearly recognized. In co-word analysis practices, social network analysis is frequently used to make networks of keyword clusters (e.g. Lee, 2008; Lee & Jeong, 2008). With social network mapping, relations between clusters can be visualized and characteristics of clusters such as importance and cohesion can be detected by calculating score of some network metric indicators such as centrality and density (Wasserman & Faust, 1994). Some software tools such as Ucinet and Pajek that have been developed for implementation of social network analysis (Borgatti, Everett, & Freeman, 2002; de Nooy, Mrvar, & Batagelj, 2005) are often used to draw graphs of keyword clusters (Pilkington, 2008; Leydesdorff, & Hellsten, 2006).

In this study, several software tools are used to carry out the above methods. Firstly, EndNote (EndNote X 3.0.1) is used to store and edit the sample articles and keywords. Then Bibexcel, a bibliometric toolbox developed by Olle Persson at Umeå University, Sweden (Persson, Danell, & Schneider, 2009), is used to figure out co-occurrence frequencies of keywords and a co-occurrence matrix. Thirdly, Ucinet (Ucinet 6 for windows) (Borgatti, Everett, & Freeman, 2002), a popular social network analysis tool, is used to calculate similarity between keywords based on the co-occurrence matrix. Two similarity measurement indexes, Jaccard index and Pearson's product-moment correlation, are calculated in this study. The fourth step is performing hierarchical cluster analysis using SPSS (SPSS Statistics 17.0) for the purpose of agglomerating keywords into groups. Finally, NetDraw, a visualization package integrated in Ucinet, is used to make social network maps of keyword clusters. The above research procedures are presented in Figure 1.

3. Data Analysis

3.1. Main Discourse Topics Emerged in the Domain Literature

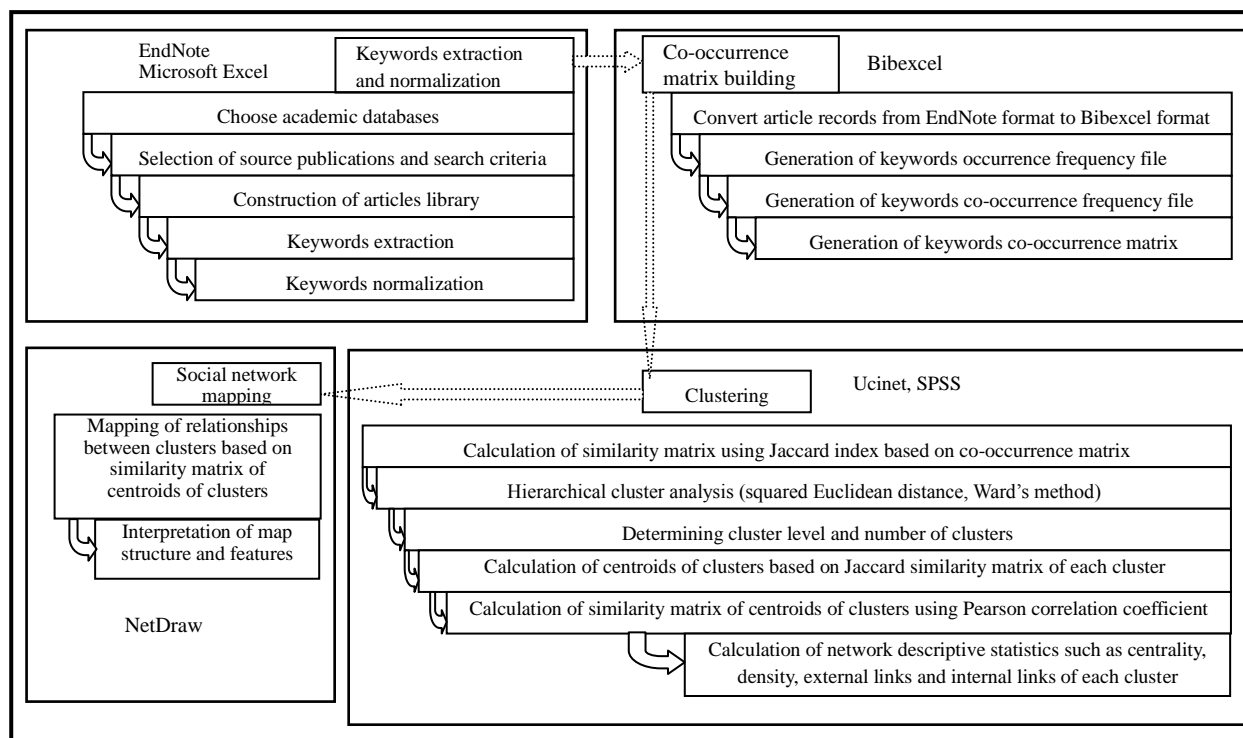


Figure 1. Procedures of bibliometric mapping of E-Learning enabled workforce development domain knowledge

Of the 125 normalized keyword terms, 85 terms appear more than twice and can be taken as representatives of main discourse topics in academic and industrial literature in E-Learning enabled workforce development. Top terms, which have occurrence frequency higher than 10, of the 85 terms are presented in Table 3. Summarizing terms listed in Table 3, core topics emerging in E-Learning enabled workforce development literature refer to following aspects of E-Learning: technologies (such as terms 3, 14, 26), E-Learning settings such as countries, industries, business enterprises, teams in workplaces, virtual learning communities (terms 4, 5, 8, 11, 25), pedagogy (term 6), management and strategy (terms 7, 12), knowledge management (terms 15, 17), users reaction (terms 16, 21, 24), competences, performances and human resources (terms 9, 10, 18), economic and cultural aspects (terms 19, 20), and effectiveness (term 22).

3.2. Co-Occurrence Matrix and Hierarchical Clustering

Through a sequence of data preparation procedures, such as output of article records from EndNote and convert of data format in Bibexcel, a 85×85 co-occurrence matrix of the 85 keyword terms with occurrence frequency higher than 2 is obtained. The highest co-occurrence frequency is 80 counts between the term pair “educational technology/systems// information technology” and “E-Learning/ computer-assisted instruction/ internet in education/ web-based instruction/ distance education”. The distribution of co-occurrence frequencies is as Table 4.

Based on the co-occurrence matrix, a similarity matrix of keywords is figured out via Ucinet. Similarity between keywords is measured using Jaccard index (Hanneman & Riddle, 2005). The 85×85 Jaccard index similarity matrix is then used as input data in SPSS to perform hierarchical cluster analysis. The 85 keywords are used as clustering variables, and the clustering process is performed on cases (Q-clustering), based on squared Euclidean distance and Ward’s method. The dendrogram of cluster analysis suggests that the 85 keywords agglomerate into three general clusters, with 17, 30, and 38 keywords in each cluster respectively. Decision about number of clusters is made considering the total number of keywords used for clustering, and components of each cluster are decided by observing the dendrogram. Subsequently, centroids of the three clusters are calculated. In this study centroid is defined as the

Table 3. Top terms with occurrence frequencies higher than 10

ID	Frequency	Terms	ID	Frequency	Terms
1	275	E-Learning/computer-assisted instruction/internet in education/web-based instruction/ distance education	14	28	Systems design/ implementation/model
2	98	career development// employees training/empowerment	15	27	knowledge/information management
3	89	educational technology/systems// information technology	16	23	attitude/ trust/ satisfaction
4	53	Industrial organization/ business enterprises/SMEs/association	17	22	workplace learning/ organizational learning/ adult learning
5	51	countries & regions	18	20	abilities/ competences
6	39	training/learning methods	19	18	economic aspects/cost/profits/ROI
7	36	management/strategy	20	17	corporate/national culture// multicultural/cross-cultural education
8	34	virtual teams/ teams in the workplace	21	17	adoption/uses/dropouts
9	33	Personnel management//Human Resource/ Capital Management	22	12	efficiency/effectiveness
10	31	EPSS/performance support/performance management	23	12	research methodology
11	31	industry/application fields	24	12	professional groups/ e-learners
12	30	leadership/executives/managers/entrepreneurship	25	11	virtual learning community/group
13	28	communication/cooperation/collaboration	26	10	virtual reality/virtuality

Table 4. Distribution of co-occurrence frequencies

Co-occurrence frequency	>70	20-42	10--19	9	8	7	6	5	4	3	2	1
Counts of term pair	2	15	23	11	13	6	14	27	43	83	198	696

mean vector of a matrix. Then, a 3×3 Pearson correlation matrix for centroids of the three clusters is calculated via Ucinet. A general map showing relationships between the three clusters is obtained based on the correlation matrix and presented in the following section. Some descriptive statistics of the map are also calculated.

3.3. Mapping of Domain Knowledge in E-Learning Enabled Workforce Development

Figure 2 shows the general three sub-areas of E-Learning enabled workforce development studies, represented by top five terms with high occurrence frequencies in each cluster, emerged from hierarchical cluster analysis result. *Size* of the three circles is decided by number of terms in each cluster, and *relations* between clusters are built on correlation similarity between centroids of each cluster. The Pearson correlation matrix for centroids of the three clusters indicated in Figure 1 verifies that the 85 keyword terms can be partitioned into three separate clusters, which is the result of hierarchical cluster analysis. Because the values of correlation coefficient between the three clusters are negative ($r_{1,3}=-0.356$, and $r_{2,3}=-0.312$) or rather weak ($r_{1,2}=0.012$). *Positions* of each cluster are assigned according to normalized density and centrality of each cluster. Density is a measure of strength of links that tie together keywords making up a cluster, and centrality of a cluster measures interaction between a subject area and other subject areas in a whole network (He, 1999). In this study, density is calculated by dividing the total of co-occurrence frequencies between keywords in a cluster by the number of all possible ties in this cluster (Borgatti, Everett, & Freeman, 2002), with the result signifying average co-occurrence frequency between a pair of keywords in the cluster, while centrality is calculated by dividing the total number of external links of a cluster by the number of keywords in this cluster, which makes an indictor denoting average co-occurrence frequency of a keyword belonging to a cluster with keywords outside of the cluster.

Scores of centrality, density, normalized centrality and normalized density and some other descriptive statistics of the three sub-areas visualized in Figure 1 are summarized in Table 5. In Table 5, External links(co-occurrence) mean co-occurrences between keywords belonging to a cluster and keywords outside of that cluster, and External links($r \geq 0.3$) denote ties of Pearson's correlation coefficient value higher than 0.3 between keywords belonging to a cluster and keywords not belonging to that cluster. Internal links (co-occurrence) represent co-occurrences between

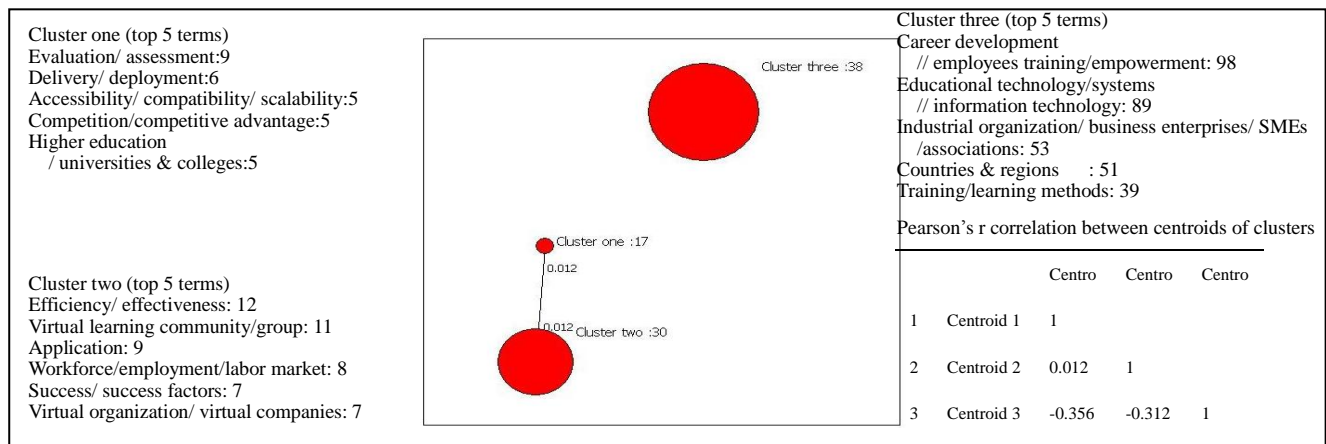


Figure2. General map of sub-areas in e-learning and workforce development studies

Table 5. Descriptive statistics of three clusters

	Centrality (Mean=7.638 Std.=0.679)	Density (Mean=0.514 Std.= 0.82)	Norm. Centrality	Norm. Density	External Links (Co-Occurrence)	Internal Links (Co-Occurrence)	External Links($r \geq 0.3$)	Internal Links($r \geq 0.3$)
Cluster 1	7.294	0.044	-0.506	-0.573	124	6	16	41
Cluster 2	7.2	0.037	-0.645	-0.582	216	16	21	23
Cluster 3	8.421	1.461	1.153	1.155	320	1027	15	48

keywords inside of a cluster, and Internal links($r \geq 0.3$) refer to ties of Pearson's correlation coefficient value higher than 0.3 between keywords in a cluster.

Among the three clusters identified, cluster 3 has the highest normalized density and centrality, which means that this cluster represents a cohesive and important sub-area in E-Learning enabled workforce development research. According to component keywords of the three clusters, main topics in cluster 3 include web-based training, career development, educational technology, E-Learning application in industrial organizations and different countries, and training and learning methods. Table 5 also shows that values of normalized centrality and normalized density of both cluster 1 and cluster 2 are negative, which means that the two sub-areas are not cohesively developed and don't have a close connection with other sub-areas. According to clustering result, cluster 1 is mainly about evaluation of E-Learning programs together with their delivery and accessibility, with a focus on higher education; cluster 2 places more attention to effectiveness and success factors of E-Learning applications, especially in virtual learning communities. Numbers of external links and internal links indicated in Table 5 provide supplementary information on the centrality and density of each cluster.

4. Conclusion and Discussion

By using co-occurrence analysis, multivariate statistical technique and social network analysis tool, this study draws out main discourse topics and three sub-areas of current domain knowledge in E-Learning enabled workforce development. 85 keyword terms have been identified as main discourse topics in the literature, which may refer to various aspects of E-Learning in the workplace such as employee training, educational technologies, organizational learning, pedagogy, virtual teams, human resource management, performance support, knowledge management, cost, attitude, adoption, and culture. Moreover, the 3 clusters have been identified as the sub-domains of knowledge in this field: Web-based employee training, Virtual learning community, E-Learning evaluation and delivery.

Servage's (2005) review on workplace E-Learning pointed out that practitioner literature concerns mainly about technology and cost while lacks attention to learner consideration in strategizing and implementation of E-learning.

Findings of our study provide evidence to Servage's conclusion. According to Table 3, the term "educational technology/systems// information technology" has the second highest occurrence frequency. Another term concerning technical issues in E-Learning, "systems design/implementation/model", also appears frequently. The cost-related topic term "economic aspects/ cost/ profits/ ROI" occurs frequently in literature too. However, in our analysis result, the terms "attitude/ trust/ satisfaction" and "adoption/ uses/ dropouts" appear with high frequencies, which means that learners attitude and reaction towards E-Learning have drawn considerable attentions in researches and practices.

Tynjala & Hakkinen (2005) provides a review on E-Learning at work with a focus on theoretical underpinnings such as adult learning, organizational learning, and communities of practice. Our findings reveal that topics on "workplace learning/ organizational learning/ adult learning" and "virtual learning community/group" are indeed covered widely in literature, as shown in Table 3. Besides, our results suggest that examining E-Learning in enterprises from a cultural perspective is of wide interest. What's more, investigating application of E-Learning for workforce development in different countries and regions, in various industries, and in industrial organizations is becoming a hot topic.

Findings of this research are helpful for understanding structure and features of current domain knowledge in E-Learning enabled workforce development, especially in the situation that various topics have emerged in subject literature, which leads to vagueness in the field. This research is limited in the following aspects: *a)* the sample articles used for extraction of domain concepts are limited in terms of sample size; *b)* "index effect" of co-word analysis could bring in noise and inaccuracy in data analysis results. Quality of data used for co-word analysis and subsequent data analysis depends largely on accuracy and distinguishability of keywords in representing domain concepts. Raw keywords provided by authors and database indexers are sometimes inconsistent in semantic meaning and morphology, which may lead to noise. Meanwhile, the process of keywords normalization unavoidably may result in loss of information carried in raw keywords.

The future work will consider improvements in the following aspects: *a)* more than two coders will perform keywords extraction and normalization; *b)* the normalization results will be refined iteratively by calculating inter-coder reliability; *c)* the results of cluster analysis of keywords will be compared based on different similarity measurements, for decision making of proper number of clusters emerged. Besides, a qualitative approach will be used for in-depth analysis and understanding of core concepts, research themes and future directions of E-Learning enabled workforce development.

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潛在數位學習者的資訊搜尋與分享行為之研究

A Study on the Behavior of Information Searching & Sharing for Potential E-Learners

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【摘要】 本研究為問卷調查分析，以台灣民眾抽樣得有效樣本數 8560 人進行研究；以資訊搜尋和資訊分享作為探討潛在數位學習者的分群變項，結合潛在類別技術做集群分析，其結果可分類「資訊搜尋偏好者」、「善用網路優勢的數位學習者」、「資訊分享偏好者」和「弱資訊使用者」四群。結果說明資訊搜尋和分享在數位學習課程的配合上可見必要性。對於相關數位學習業者或政府機關推行網路課程時，可以搭配正確知識或資料讓學習者藉由搜尋來增加知識取得；此外在網路學習下，課程若能搭配同步討論，也將對學習者有更多學習效益。

【關鍵字】 數位學習者、資訊搜尋、資訊分享、潛在類別分析

Abstract: This study examined the findings of a survey given to 8560 Taiwanese and found that there are four potential E-learner clusters. These clusters include: "Information search preferences"; "Using internet advantage of E-learner"; "Information sharing preferences" and "Weak-information user". The statistical method of latent class analysis was applied which uncovered the factors leading to the separation of the groups. When users are addressed, according to their potential E-learner cluster, industries, educational institutions or governments may implement online programs which can give learners the proper guidance to related information thus heightening their learning advantage. The results of this experiment suggest that the use of the statistical information gathered, which defines group boundaries, can be used to enhance teaching methods by assigning strategies from group characteristics to teaching models. Therefore under computer supported collaborative learning, if the online asynchronous discussion is combined with the curriculum framework, learners will have a more effective learning experience.

Keywords: E-learner, information searching, information sharing, latent class analysis

1.前言

這幾年來台灣推行數位學習的活動可說是相當如火如荼（數位內容產業推動服務網，無日期）。從行政部門、學校機構和業界都可以發現許多線上課程的推廣和可自修內容的數位教材，表示台灣在數位學習的推展上是個不錯的發展環境。研究者認為數位學習者在學習的環境中，資訊的搜尋(Kuhlthau, 1991)和分享（吳有順，2000；Lin, 2008）是有其必要性的，這樣的學習策略將有助於學習者在學習過程中，遇到問題或是困難時，他們可以網路上找到幫助。在搜尋引擎盛行的現在，許多人喜歡透過線上搜尋來瞭解更多自己想知道的事情，而且他們也喜歡分享自己的經驗和知識((Pfeil, Zaphiris, & Ang, 2006))。對於學習者而言，有資料搜尋和分享的習慣與判斷資料正確的能力是重要的。有研究(Kuhlthau, 1991)指出，學習正確的資料搜尋是有助於知識的成長，此外懂得分享知識和經驗，亦是讓知識遷移和多方驗證的方式之一，而最明顯的是 web2.0 下所使用的工具。網路對數位學習者是相當重要的，除了網路環境的基礎建設穩定外，更重要的是提供一個適合的學習策略來輔助數位為學習者在使用搜尋和分享技巧時能有更不錯效果。

本研究主要從電腦使用者中來發覺潛在數位學習者在資訊搜尋與分享的行為情況，這資訊搜尋與分享的行為對於數位學習者的行為習慣是重要的，在統計方法上，本研究透過潛在類別分析的技術，分類出潛在數位學習者的資訊搜尋與分享的行為模式，並報告這些潛在數位學習者的背景資訊（包括性別、年紀、教育程度）和電腦及網路使用情形（包括上網時間、上網方式、行動上網與信箱使用），希冀能提供政府部門、教育機構和有興趣的團體更多的參考。

2.文獻探討

本研究在文獻上的討論包含資訊搜尋與分享對於數位學習的重要性和潛在類別分析的技術應用。在資訊搜尋與分享的重要性上，我們知道對於一個學習者而言，除了教學者給於知識外，重要的是他們自己能夠找到正確的資訊，吸收消化後成為自己的知識。在網際網路發展成熟的現今，許多研究開始探討學習者與資訊搜尋行為的關係，這些研究結果表現出學習者若能有效習得資訊搜尋技能，相對的知識的獲得是相當豐富的（Lazonder, Biemans, & Wopereis, 2000; Kuhlthau, 1991）。產生資訊搜尋行為之動機，根據學者(Belkin, 1980; Derr, 1983)的研究，綜合上來說，可以瞭解到當個體認知不足於，需要更多的資訊協助，而藉由搜尋的策略來滿足資訊的獲得。在現在的網路世界，我們可以發現表述自己的意見和分享知識成為另一種網路的活動。過去網路上的使用行為，以單向的資訊接受為主，現在轉變為網路平台或社群建構的內容生產者。藉由「參與」和「互動」，於是 Web2.0 概念開始產生。從學習的角度來看，學習者除了獲取知識的同時，也可以分享知識。學者 Collis 與 Moonen（2008）指出，大學教育結合 Web2.0 的應用其發展性仍很大，Web2.0 的使用已成為學生們生活的一部份。此外英國聯合資訊系統委員會（Joint Information System Committee, JISC）的研究發現網路是大學生自主學習時的首要選擇（Anderson, 2007）。Web2.0 提供資訊搜尋及整合資訊，對於數位學習者而言是一個很不錯的知識獲得來源。

在潛在類別分析的技術應用方面。我們瞭解到潛在變數(Latent variables)是無法像物理測量一樣，直接測量得到數據，我們需要以統計方法來推估出來的變數。而這些潛在變數是一種抽象的心理特質，因此需要以操作型定義來說明。在本研究中，研究者欲藉由資訊搜尋和資訊分享的行為來瞭解和數位學習者間的潛在關係。在許多分析法中，因著測量單位尺度的不同，因此選擇的技術有所考量。本研究以二元計分為主，根據潛在類別模式(Latent class

modeling, LCA)的原理定義,採用以二元計分上來探討潛在變數模型化是相當不錯的分析技術(Goodman, 2002)。此外使用潛在類別分析是再進行群集的處理,也就是物以類聚的作法,然後研究者可以依據群集的特性進行更多策略的應用。在本研究上,找出潛在數位學習者與資訊搜尋和資訊分享的行為來進行分群,以瞭解搜尋和分享程度不同的群組,該給以何種學習策略的配合。

3.研究方法

本研究之研究方法採用次級資料分析。透過有政府機關所做的問卷調查來進行研究探索。本研究的資料來源採用臺灣行政院主計處 97 年度個人/家戶數位落差調查問卷,以電話訪問並年齡滿十二歲者。該調查採全國分層抽樣,樣本具有一定代表性。問卷填答人數上,因本研究僅探討數位學習者的研究,採用問卷中的「請問您曾經透過網路進行視訊課程、線上學習或測驗嗎?」來進行參與數位學習情況的決定,而以刪除無效樣本後的 8560 人為分析單位。

在研究工具上,選問卷中有關資訊搜尋和資訊分享相關的問題來做進一步的分析。問題陳述包含,「請問您曾使用線上傳呼軟體(MSN、ICQ、Yahoo 即時通等)和您的親人好友聯絡嗎?」、「請問您會上網搜尋生活資訊(如氣象、車票等)嗎?」、「請問您會上網搜尋與工作或課業相關資訊嗎?」、「請問您曾經上網發問或搜尋其他網友分享的經驗嗎?」和「請問您曾經上網提供知識或經驗給他人參考嗎,如奇摩知識+或維基百科?」。上述題目的問答方式經過整理後以二元計分做處理。本研究以潛在類別分析技術將所關心的題目來進行分析,瞭解在資訊搜尋和資訊分享的答題反應上找到與潛在數位學習者的關係性。

4. 研究結果

本研究主要從三方面探討,包含潛在數位學習者的資訊搜尋與分享行為結構分析、潛在數位學習者的背景資訊與潛在數位學習者的電腦及網路使用情形。

在潛在數位學習者的資訊搜尋與分享行為結構分析的討論上:本研究所進行的潛在類別分析,係使用 Vermunt 與 Magidson (2005) 所發展的 LatentGOLD4.0 軟體。模式適配檢驗則利用 BIC 指標來判斷(邱皓政, 2008; Nylund, Asparouhov & Muthén, 2006)。以資訊搜尋和資訊分享相關試題作為內容向度進行分析,將有無進行數位學習的行為作為共變數進行分析。為了瞭解這些元素是否能產生不同的群組現象,因此採用探索性潛在類別分析。分析的結果顯示,當潛在類別為四類時的模式適配情況最佳, $BIC=40754$ 數值為最小,這四類族群類型如圖 1 所示,詳細各潛在類別的條件機率、負荷量 (loading) 和解釋力 (R^2) 等係數如表 1 所示。

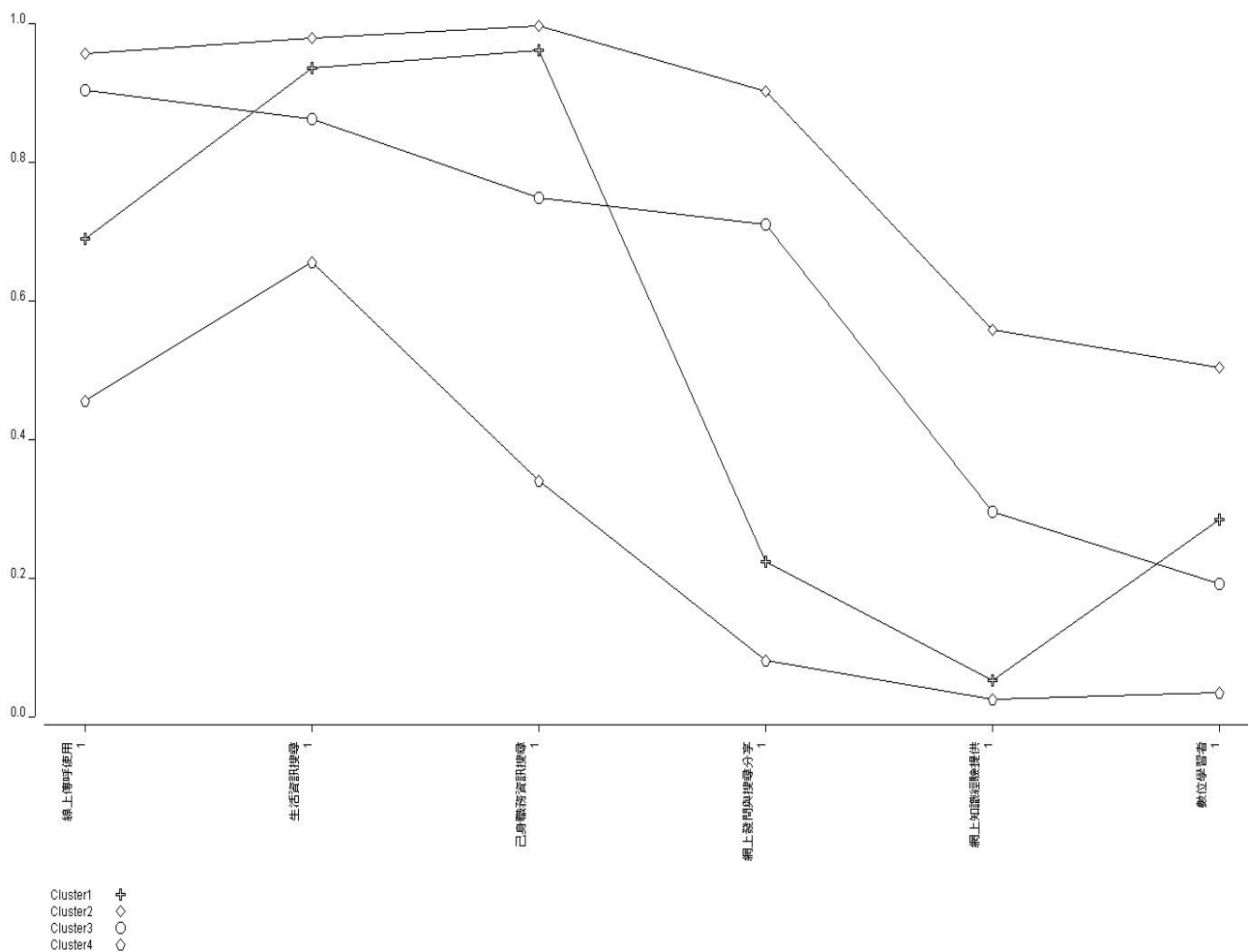


圖 1 潛在數位學習者的資訊搜尋與分享行為結構分析圖

從線條圖形可以很明顯的看出潛在數位學習者在資訊搜尋和分享上大致可分四種不同潛在結構的型態。以參與數位學習情況為共變項後，可以發現四個群組在資訊搜尋和分享的分類情況。圖 1 中 y 軸為機率，x 軸為資訊搜尋和分享的變數。而組 2 可以發現歸類於數位學習者的組群機率最高；而組 4 表示為數位學習者的組群最低。此外組 2 同時在資訊搜尋和分享的行為也比其他三組所表現的機率來的高。組 4 則都最低。但是組 1 和組 3 的群聚型態比較特別，他們歸類於數位學習者的機率很接近，但組 1 在資訊搜尋的行為機率高但資訊分享機率低。組 3 則反過來。

表 1 潛在數位學習者的資訊搜尋與分享行為條件機表

變數	組 1	組 2	組 3	組 4	loading	R ²
線上傳呼使用	0.2836	0.3936	0.2430	0.0798	0.4286	0.1837
生活資訊搜尋	0.3394	0.3547	0.2044	0.1015	0.3407	0.1161
己身職務資訊搜尋	0.3711	0.3841	0.1888	0.0560	0.6050	0.3660
網上發問與搜尋分享	0.1375	0.5556	0.2858	0.0211	0.6652	0.4426
網上知識經驗提供	0.0647	0.6842	0.2378	0.0134	0.5095	0.2595
總體	0.3248	0.3245	0.2122	0.1384		
人數	3021	3731	801	1007		

根據表 1 的結果可以發現變數中，以「己身職務資訊搜尋」和「網上發問與搜尋分享」的解釋力佔較多，表示資訊搜尋的面向表現較大。根據上述資料的各組比例分配情況，本研究試著將各組命名如下：組 1-資訊搜尋偏好者，組 2-善用網路優勢的數位學習者；組 3-資訊分享偏好者；組 4-弱資訊使用者。這些不同的組群在未來進行數位學習時，可以考量不同的網路使用習慣性來加以輔助。

在潛在數位學習者的背景資訊的討論上：包含探討性別、年紀、教育程度（表 2）。在性別的分配上，除了組 4 的差異大一點點外，其他三組的人數分配很接近，表示男女結構很一致，在資訊搜尋和分享在性別上的差異不大。在年紀上可以發現，組 1 最多分佈在 30-60 歲間；組 2 是 15-40 歲間；組 3 是 15-30 歲間；組 4 是 30-60 歲間。從這樣的分佈可以瞭解到 15 歲後的年紀開始大量使用網路，以 30 歲左右的年齡層為最多，而這年齡也開始接觸大量的資訊搜尋和分享的時候。而年紀過大或過小對於網路的使用量顯然較低。這樣的訊息說明數位學習的發展未來可以盡一步考量學童和老年的學習內容或是人機介面的設計來著手。從教育程度上可以發現，組 1、2 和組 3 都以大專和高中人數眾多；尤其組 2 是大學生最多；而組 4 則是國中到大學有 14% 到 19% 的比例。由這樣的結果可以瞭解到，現階段的求學者需要在知識的獲取和分享上或許不少。從大專和高中的教學來看，結合網路科技的使用是有輔助的必要性。

綜合上述可以瞭解到，當今使用網路來進行求知或是搜尋資料等網路行為，事實上男女都有這樣的需求，所以課程設計上可以細分不同使用者的需求來設計，以提高學習者為中心的課程設計。此外目前線上學習的推動還是可以從高中生和大專生來進行課程設計，或許把教學課程中，需要反覆練習的學科，如微積分、線性代數等數學科目透過影音，讓學習者可以藉由線上錄影反覆練習自己不熟的單元。或是許多電腦課程（文書作業、多媒體技術）或其他軟體（統計軟體、Matlab 軟體）的操作可以錄製起來，讓學習者可以在非上課期間來習得，也相對讓授課老師來解說學生在學習上有困難的部分。此外，許多年紀太大或國小學童等學習者，在進行線上課程的設計時，一定要考量到年紀大的學習者的網路操作經驗和國小學童的資訊處理認知能力的情況，可能年紀大的學習者有資訊恐懼感，不敢隨意按鈕；而學童很喜歡按鈕，但是不知道自己在作什麼，以上這些情況教學者，都可以進行個人化的教導和輔助，來幫助他們對網路輔助學習有更多受益。

表 2

性別	組 1	組 2	組 3	組 4	總和
女	1479(48.96)	1771(47.47)	327(40.82)	441(43.79)	4018(46.94)
男	1542(51.04)	1960(52.53)	474(59.18)	566(56.21)	4542(53.06)
年紀	組 1	組 2	組 3	組 4	總和
12-14 歲	157(5.20)	201(5.39)	96(11.99)	67(6.65)	521(6.09)
15-20 歲	357(11.82)	915(24.52)	216(26.97)	61(6.06)	1549(18.10)
21-30 歲	480(15.89)	1161(31.12)	185(23.10)	140(13.90)	1966(22.97)
31-40 歲	830(27.47)	888(23.80)	152(18.98)	244(24.23)	2114(24.70)
51-60 歲	765(25.32)	408(10.94)	88(10.99)	258(25.62)	1519(17.75)
41-50 歲	363(12.02)	143(3.83)	51(6.37)	188(18.67)	745(8.70)
61-64 歲	35(1.16)	9(0.24)	5(0.62)	22(2.18)	71(0.83)
65 歲以上	34(1.13)	6(0.16)	8(1.00)	27(2.68)	75(0.88)

續表 2

教育程度	組 1	組 2	組 3	組 4	總和
不識字或自修	4(0.13)	1(0.03)	0(0.00)	2(0.20)	7(0.08)
小學	38(1.26)	25(0.67)	11(1.37)	24(2.38)	98(1.14)
國中或初中	250(8.28)	300(8.04)	143(17.85)	158(15.69)	851(9.94)
高中、職(含五專前三年)	1071(35.45)	994(26.64)	319(39.83)	500(19.65)	2884(33.69)
專科	584(19.33)	585(15.68)	121(15.11)	166(16.48)	1456(17.07)
大學	887(29.26)	1531(41.03)	192(23.97)	144(14.30)	2754(32.17)
研究所及以上	187(6.19)	295(7.91)	15(1.87)	13(1.29)	510(5.96)
總和	3021	3731	801	1007	8560

註：括弧內數值為百分比

在潛在數位學習者的電腦及網路使用情形的討論上，包含探討上網時間、上網方式、行動上網與信箱使用（表 3）。在扣除無法確認上網時間外，可以發現組 1、2 和 3 在四小時內的使用量比較佔多數，表示他們在資訊搜尋和分享上的時間分配上有一定的比例；而組 4 在二小時內比較多，這從圖 1 的組 4 折線圖可以相互呼應。在上網方式上，全部組別在寬頻使用上，都達 94% 的高百分比。從數位學習的基礎環境建置來看，網路使用者幾乎都使用寬頻，未來在推動線上影音教學、多媒體互動式學習等課程設計可以更容易推行。在行動上網上，各組沒有的情況佔滿高的比例；不過組 2 使用行動載具的比例也不少，約近四成左右。目前使用行動載具為數位學習的課程設計仍是有限，可能無線寬頻環境的建置尚未普及而且價格的限制也是其一，未來使用無線環境來進行數位學習是一個契機，是個可耕耘的方向。而信箱的使用，在組 1、2 和組 3 的比例很高，有八、九成；而組 4 也近七成。表示信箱的使用對大家很生活化了。在數位學習環境上除了考量 web2.0 的結合外，電子信箱的使用也是有存在的必要性，是一種非同步的傳達知識和訊息的工具。

綜合上述，當我們在進行線上教學的活動時，可以考量到寬頻的優勢是可以多加利用，譬如教材可以加入影音多媒體，讓學習增加更多元的刺激，此外不同媒體的表現也有助於學習者的認知理解。另外，電子信箱以成為每個網路使用者的必備工具之一。學習者不一定每天會上論壇討論，但是可以多藉由電子信箱來做為問題的提問和接受大家的回應，如此可以讓學習更方便和有效率。

表 3

上網時間	組 1	組 2	組 3	組 4	總和
1 小時內	1186(39.26)	754(20.21)	181(22.60)	444(44.09)	2565(29.96)
1-2 小時	626(20.72)	790(21.17)	176(21.97)	146(14.50)	1738(20.30)
2-3 小時	321(10.63)	647(17.34)	121(15.11)	91(9.04)	1180(13.79)
3-4 小時	223(7.38)	419(11.23)	98(12.23)	52(5.16)	792(9.25)
4-5 小時	135(4.47)	297(7.96)	65(8.11)	39(3.87)	536(6.26)
5-6 小時	86(2.85)	202(5.41)	40(4.99)	25(2.48)	353(4.12)
6-7 小時	19(0.63)	38(1.02)	11(1.37)	4(0.40)	72(0.84)
7-8 小時	87(2.88)	181(4.85)	23(2.87)	11(1.09)	302(3.53)
8-9 小時	9(0.30)	13(0.35)	1(0.12)	1(0.10)	24(0.28)
9-10 小時	38(1.26)	110(2.95)	18(2.25)	12(1.19)	178(2.08)

10-11 小時	3(0.10)	9(0.24)	3(0.37)	0(0.00)	15(0.18)
續表 3					
上網時間	組 1	組 2	組 3	組 4	總和
11-12 小時	15(0.50)	67(1.80)	3(0.37)	8(0.79)	93(1.09)
12-13 小時	1(0.03)	4(0.11)	3(0.37)	1(0.10)	9(0.11)
13-14 小時	0(0.00)	6(0.16)	0(0.00)	0(0.00)	6(0.07)
14-15 小時	0(0.00)	7(0.19)	0(0.00)	3(0.30)	10(0.12)
15-16 小時	3(0.10)	13(0.35)	3(0.37)	2(0.20)	21(0.25)
不一定	269(8.90)	174(4.66)	55(6.87)	168(16.68)	666(7.78)
上網方式	組 1	組 2	組 3	組 4	總和
寬頻	2871(95.03)	3574(95.79)	760(94.88)	955(94.84)	8160(95.33)
窄頻	78(2.58)	59(1.58)	13(1.62)	26(2.58)	176(2.06)
3G、Wi-Fi、Wimax	72(2.38)	98(2.63)	28(3.50)	26(2.58)	224(2.62)
行動上網	組 1	組 2	組 3	組 4	總和
手機/PDA	558(18.47)	1403(37.60)	232(28.96)	117(11.67)	2310(26.99)
筆記型電腦	518(17.15)	896(24.02)	146(18.23)	88(8.74)	1648(19.25)
都沒有	1945(64.38)	1432(38.38)	423(52.81)	802(79.64)	4602(53.76)
信箱使用	組 1	組 2	組 3	組 4	總和
有	2672(88.45)	3658(98.04)	738(92.13)	683(67.83)	7751(90.55)
沒	349(11.55)	73(1.96)	63(7.87)	324(32.17)	809(9.45)
總和	3021	3731	801	1007	8560

註：括弧內數值為百分比

5. 結論與建議

本研究試著從資訊搜尋與分享的角度出發，去瞭解到潛在數位學習者的分類情況。藉由潛在類別分析技術，可以得到不同的學習群族。這些學習群族的歸類，大致可分為「資訊搜尋偏好者」、「善用網路優勢的數位學習者」、「資訊分享偏好者」和「弱資訊使用者」。這些不同的組群在未來進行數位學習時，可以考量不同的網路使用習慣性來加以輔助以提高更大學習效能。對於推廣數位學習的政府單位或是企業組可以先瞭解不同潛在數位學習者的特徵，提供合適的學習策略來輔助學習，使得數位學習的能有效落實於全民。在建議上，本研究使用的問卷，並非以數位學習者的瞭解來設計，因此以挑選相關問題結合統計技術來推估，希冀日後能針對數位學習者發展合適的量表來精確瞭解他們的在資訊搜尋與分享的情況。

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國民小學圖書資訊教師專業知能發展之線上課程設計

The Design of Online-Learning in Elementary Library-Information Teachers' Professional Competence Development

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【摘要】 台灣地區國小圖書館因人力、物力和經費不足，一直是圖書館發展事業中最弱的一環，又以人力資源缺乏為最關鍵因素。本研究為改善人力資源貧乏之窘狀，率先規劃「國小圖書資訊知能」線上課程，以 ADDIE 模式發展，由學科專家檢視內容品質，期能提供 2,600 多所圖書館業務人員一個增進專業知能的網路進修機會，使其具備圖書館專業知能以服務所屬師生。課程使用者測試滿意度結果多為非常滿意與很滿意，教材內容與架構面向分數最高，顯示此課程符合現職國小圖書資訊教師之學習需求。本研究將依據使用者回饋意見編寫手冊，以利後續推廣線上課程供學習者使用。

【关键词】 圖書資訊教師、國小圖書館、網路在職進修、線上學習、ADDIE

Abstract: Lacking of manpower is the most severe problem in elementary school library development in Taiwan. To improve the difficulty of human resource management, this study developed a series of online courses to empower librarian teachers' professional competences. The ADDIE model was used for the online course design. The online courses were delivered which can be accessed by all librarian teachers national wide. The results of satisfaction survey showed the users were very satisfied on the course. In addition, feedbacks and problem discussed from and by the users were collected. The researchers anticipated that the online course could not only empower teachers' professional competence but also could effectively promote library user education and reading education in their school.

Keywords: Library-Information Teacher, elementary school library, online in-service professional development training, online learning, ADDIE

1.研究背景與動機

面對知識經濟時代的挑戰，如何培育具有競爭力的人才，已成為各國政府教育部門的目標和發展重點。OECD(2000)研究報告亦指出，民眾的閱讀能力是展現國家競爭力的重要指標，國家最大的投資，應該是強化民眾的閱讀能力。連續三年位居全球競爭力龍頭寶座的芬蘭，

其優越的競爭力來自於擬定長期策略、堅持核心價值、改革師資、豐沛的圖書館資源以供大量閱讀(蕭富元, 2007), 這些競爭力亦讓芬蘭連續在 PISA 閱讀與科學測驗兩項評比稱霸。近年來多次來台取經的香港, 連續在 2007 年 PIRLS 及 PISA 評比中表現亮眼, 積極教改與每校配置專職圖書館教師力倡閱讀教育是其成功主因。反觀同為華語文重鎮的台灣, 卻名列 57 個參與 PISA 國家中之第 16, 表現不如鄰近韓國與日本; 在 PIRLS 評比亦名列 22, 居華人地區之末(何琦瑜, 2007a), 足見台灣地區中小學童的閱讀能力猶待提升與加強。

為提升學童閱讀素養, 台灣教育部近年來積極推動各項閱讀計畫, 投入逾億經費添購圖書, 期能逐年充實國中小閱讀環境(教育部國教司, 2008)。然, 圖書館空有豐富館藏仍舊無法使閱讀種子茁壯, 因為還需要有閱讀園丁的時時灌溉與照顧。艾登·錢伯斯指出:「孩子是否喜歡閱讀, 和他們所接觸的藏書有著很密切的關係。掌理這一切的圖書館員, 扮演相當關鍵的角色。」(引自何琦瑜, 2007a)。在台灣, 國中小學圖書館的經營管理與利用一直是圖書館事業發展中最弱的一環(曾雪娥, 1997), 其主因係囿於人員編制、經費配置無明文規定所致。根據呂瑞蓮與林紀慧(2005)全台國小圖書館調查指出, 全台僅兩成學校設有專職人員, 高達 85.4% 國小圖書館業務人員未受過完整專業訓練, 72% 調查樣本想增進圖書資訊相關知能, 亦有 45% 希望參與有學分的遠距學習。面對如此高度的專業知能訓練需求, 如何提供一適切的國小圖書館學專業知能訓練課程, 是本研究的研究目標。

隨著資訊科技的快速更新, 線上學習無遠弗屆的特性, 改變原有傳統實體進修的方式, 透過網路參與進修活動亦成為現代教師另一種充實專業知能的管道。林紀慧與蔡振地(2008)即指出, 台灣軟硬體設備極有利推動國小教師參與網路在職進修, 79.9% 教師表示願意參與網路在職進修。是以, 規劃線上教師專業知能發展課程已為時勢所趨。如何藉助資訊科技的特性, 提供全台各地 2,600 餘所國小可無遠弗屆地普享訓練機會, 免除舟車勞頓之苦, 為本研究研究動機之一。因此, 本研究擬規劃設計一線上國小圖書館專業知能課程, 供現職國小圖書館業務人員及有心修習此專業知能者一彈性的進修管道, 使其具備圖書館專業知能, 以有效經營管理圖書館、推廣圖書館利用教育、支援學校教學、並舉辦各種閱讀教育活動, 以提升國小學童資訊搜尋與閱讀理解能力。

2. 文獻分析

2.1. 台灣地區國小圖書館現況與困境

許多研究(蘇國榮, 1996; 劉貞孜, 1995; 曾雪娥, 1997; 賴苑玲, 2000)均指出國小圖書館是支援教師教學, 輔助學生學習的最佳場所, 並強調應於國小階段培養學童資訊蒐集、辨識及使用能力, 使資訊素養養成教育能向下紮根。在政府大力推動教育改革、教育鬆綁的政策引導下, 學校教育主軸轉而重視學生獨立自主學習能力的培養, 並強調應用資訊科技教導學生如何獲取知識、熟悉圖書館各類知識查檢技巧、以激發其思考創造的能力(賴苑玲, 1998)。是以, 圖書館已從一個閱讀場所, 轉變成協助學習、支援教學的關鍵角色。

在國外, 許多中小學圖書館與校內教師一起合作, 共同指導學生利用圖書館各項資源進行學習, 使其具備良好資訊素養基礎(Rohrman, 2000; Floyd, Colvin & Bodu, 2008; Montiel-Overall, 2008)。反觀台灣的學校圖書館仍深受專業人力的嚴重不足、圖書館負責教師缺乏圖書館利用教育專業知能、缺乏經費及設備等困擾(熊惠娟, 2001; 林春櫻, 2002; 黃幸雯, 2002; 呂瑞蓮、林紀慧, 2005), 致台灣地區中小學圖書館利用課程多停留在閱讀指導階段, 未能進一步指導學生充分利用圖書館資源、圖書館經營僅限借還書服務, 與歐美先進國家發展相去甚遠。天下雜誌 2007 年針對全台 23 縣市中小學調查指出: 縣市政府及學校雖有特別重視圖書館經營, 但整體而言, 台灣中小學圖書館在閱讀教育中仍是「脆弱的後盾」

(何琦瑜, 2007b)。經費不足、乏人照顧等經營問題在近十年相關研究中不斷地被提出, 此亦是各校圖書館長期以來面臨的現實問題。

由上觀之, 圖書館之人力不足、缺乏專業知能、經費匱乏已成為台灣地區中小學圖書館經營管理之最大困境。中小學圖書館是培植國家未來主人翁具備競爭力之重要場域, 其營運的良窳將成為國家競爭力優劣的重要指標(國家圖書館, 2005), 其功能是否完全發揮, 端賴其間運作的人力是否具備專業知能以推展業務。如何提升中小學圖書館人員之專業知能, 落實其成為閱讀教育尖兵的角色, 是相關單位提振國小圖書館事業發展時的首要目標。

2.2. 圖書資訊教師專業知能發展

國小教師向來擔負培育國家人才重任的第一線尖兵, 想要使資訊教育向下紮根、培植國家競爭力於未來, 教師的能力是最重要的因素(張雅玲, 2001)。是以, 欲提振國小圖書館經營績效, 應率先解決現職人員專業知能不足的困境, 協助其具備圖書館學專業知能, 以推展國小圖書館事業, 使其扮演推動校內閱讀風氣和提供教學資源的前線尖兵。

執世界牛耳的美國, 在 1988 年版的 Information power 中(AASL & AECT, 1988)明確指出一名圖書館媒體專家須具備圖書館學與資訊科學、教育背景、傳播理論、科學技術等知能, 並於 1998 年新版 Information Power 中重新詮釋一名圖書媒體專家應具備教師、教學夥伴、資訊專家、計劃行政管理等角色(AASL & AECT, 1998)。陳明來(2001)亦指出美國各州均要求學校圖書館教學媒體專家須先取得教師資格, 再修習圖書館學或教學媒體方面碩士學位, 或修習 12 學分的圖書館學或視聽課程。在台灣雖明列國小圖書館應設組長或幹事, 並由具圖書資訊專業之教師兼任, 此類人員至少曾接受六週的專業訓練, 每年須參與六小時的在職訓練(教育部, 2002), 但對圖書教師的職掌、專業資格認定、減授鐘點等均付之闕如。

在台灣, 許多研究指出: 一名專業圖書教師須具國小教師資格, 有豐富教學經驗、熟悉國小課程標準與教學方法, 並受過圖書館學專業知能訓練, 及具備資訊素養(蘇國榮, 1996; 李宗薇, 1998; 陳美蓉, 1999; 徐月眉, 2002; 陳海泓, 2002; 苗雅君, 2004)。呂瑞蓮和林紀慧(2008)指出一名國小圖書資訊教師應具備: 教育專業知能、圖書館學素養、資訊素養、個人素養與態度等四大知能, 然, 現有從業人員的圖書館學素養為四大向度之末, 並以未擔任此項業務者知能具備程度優於有擔任者, 建議應該優先從現職圖書館人員加以培訓。

是以, 提供現職國小圖書館業務人員在職進修管道以增進圖書館學專業知能已是刻不容緩之趨勢。唯有第一線圖書館業務人員具備專業知能, 才能正確且有效地推廣圖書館利用活動、培養學童具備資訊素養與獨立學習能力、與校內教師進行協同教學計畫, 提供及製作各種教學資源供師生使用, 真正落實圖書館為學校教學資源中心之使命與願景。

2.3. 線上學習的特性與功能

美國思科(Cisco)認為數位學習(e-Learning)是: 透過網際網路, 即時傳遞資訊及知識給所需要人, 包含正式的訓練及課程, 也包括資訊傳遞、網路互動、知識管理與績效管理(Cisco, 2003)。近年來隨著資訊科技的蓬勃發展, 數位學習亦與線上學習(online learning)混用。本研究發展之線上課程即屬透過網際網路傳遞知識的一種線上學習方式, 並結合學習管理平台(LMS, Learning Management System)的功能, 提供教學者和學習者在線上進行教材管理與學習、互動討論與紀錄管理等各項工作。

相較於傳統教學情境, 線上學習開創新的學習典範。在教學活動上, 線上學習強調「學」的活動, 而非「教」的活動。在課程設計上, 偏重對「學習者」的掌握, 而非「知識」的分析處理。由於線上學習環境具破除學習時空的藩籬、多元化的學習資源、互動式學習的特性(林奇賢, 1998), 及具非同步、多方向、個別化及自動記錄學習歷程等優勢(洪明洲, 1999),

且可促使學生主動學習、促使合作學習、訓練解決問題能力等特質（林甘敏，1999），加上多媒體技術的進步，使得線上課程如雨後春筍般的展現（許正妹、張奕華，2005），提供無法參與實體學習者另一個多元的學習管道。透過線上學習時間與空間的自由及彈性，學習者可藉由同步（synchronous）、非同步（asynchronous）或混成（blending）的學習活動（陳年興、楊錦潭，2006），積極參與學習社群，藉由互動教學及群體討論的學習機制，刺激學生思考多重解決方案，進而帶動團體合作學習活動以獲致更大的學習成效。

本研究採擷線上學習之優勢，以發展線上國小圖書館專業知能培訓課程，便利現職國小圖書館業務人員或有興趣者，經由混成線上非同步和同步的方式參與學習。學習者可視個人時間自由選擇時段上網閱讀教材，並結合線上同步工具，提供教師與學習者可於同一時間、不同地點線上即時互動討論，亦適時補充教材中較難理解的觀念或檢討個人作業，以即時釐清學習過程中易產生之學習問題。

3.數位教材設計

本研究目的在設計一套培訓國小圖書館學專業知能的數位教材，以線上進修方式，便利不同地區的國小圖書館業務人員增進圖書館學專業知能。數位教材的開發是依據業界和教育界最常採用的 Dick & Carey 模式（Dick & Carey, 1996），其實施階段包括：分析（Analysis）、設計（Design）、發展（Development）、實施（Implementation）和評鑑（Evaluation），以下就各階段工作任務分別說明。

3.1.分析階段

本階段根據文獻分析結果發展國小圖書館專業知能課程，並就就學習者、現有資源、媒體及任務進行分析。學習者分析對象以國小圖書館業務人員為主，根據文獻分析結果（張金玲、林紀慧，2000；呂瑞蓮、林紀慧，2005；周倩、呂瑞蓮，2009）得知，現職國小圖書館業務人員多為各校組長、級(科)任教師及職員，年齡集中於 25 至 50 歲間，考量成人學習者特性，教材內容須合乎其實際工作需求，俾利引起其學習動機。此外，本研究亦分析現有資源，包括開課教師歷年教學內容及實務經驗，及有願意參與本研究之學科專家與教學設計專家。

教材開發工具選擇 Microsoft Producer 2003，其具備教材開發工具免費，教師錄製教材方式符合原先課堂教學習慣等優點。本研究研發教材總時數約 13 小時，任務分析方式採 Gagne 階層式工作分析（hierarchical task analysis），將複雜的課程內容逐步拆解成單一概念、原則和步驟，直到學習者已經具備起點行為為止（Gagne, 1985）。課程內容共分成七個單元，各單元再依內容主題往下細分成五至八個小單元，各小單元講授時間控制在 15 至 25 分鐘間，俾利學習者可依照個人時間調整學習數量和速度，見圖 1。

3.2.設計階段

本階段工作內容為教材內容設計、風格介面設計和教材開發流程。教材內容設計分成訂定單元教學目標、擬定課程大綱及訂定教學順序；風格介面設計主要包括投影片樣版設計、Microsoft Producer 2003 輸出介面制定；教材開發流程則說明開課教師、教學設計者、媒體製作人員、學科內容專家與教學設計專家於開發過程中之扮演之角色與職責。

小學圖書館概論課程架構						
單元一 圖書館 自動化實務	單元二 圖書資料分類	單元三 圖書資料編目	單元四 視聽資料編目	單元五 分類編目實務探討	單元六 小學圖書館 自動化系統評估	單元七 小學圖書館 管理概論
1-1 圖書館自動化 流程	2-1 圖書資料 分類編目概述	3-1 圖書資料 編目概述	4-1 視聽資料簡介	5-1 總論複分表介紹	6-1 小學自動化系統 簡介	7-1 小學圖書館 經營管理概述
1-2 自動化前置作業 一次書篇	2-2 認識圖書資料 分類	3-2 圖書資料 著錄項目(1)	4-2 視聽資料 分類編目概述	5-2 套書分類編目概述	6-2 編目模組功能 簡介(1)	7-2 館藏發展計畫
1-3 自動化前置作業 整理篇	2-3 圖書資料分類 原則	3-3 圖書資料 著錄項目(2)	4-3 視聽資料 分類編目規則	5-3 套書分類編目實例	6-3 編目模組功能 簡介(2)	7-3 典藏閱覽服務 (一)圖書
1-4 圖書館動線規劃	2-4 認識圖書索書號	3-4 機讀編目 格式簡介	4-4 常見視聽資料 編目實例	5-4 兒童繪本處理原則	6-4 查詢模組功能 簡介	7-4 典藏閱覽服務 (二)視聽資料
1-5 編目前加工作業	2-5 探討圖書資料 分類案例	3-5 原始編目 實例解說	4-5 視聽資料 進階編目(1)	5-5 編目後 加工作業(1)	6-5 流通模組功能 簡介	7-5 典藏閱覽服務 (三)期刊
		3-6 抄錄編目 實例解說	4-6 視聽資料 進階編目(2)	5-6 編目後 加工作業(2)	6-6 系統其他功能 簡介	7-6 典藏閱覽服務 (四)閱覽工作
		3-7 制定館藏 編目政策(1)	4-7 視聽資料 分類編目練習			7-7 推廣及利用教育
		3-8 制定館藏 編目政策(2)	4-8 視聽資料加工作業			

圖 1 課程內容任務層級分析

3.3. 發展階段

本階段規劃包括腳本撰寫、影片拍攝、剪輯與製作素材等，利用 Microsoft Producer 2003、Photoshop CS2.0 及會聲會影 11.0 等軟體進行教材的實際開發。教材內容呈現策略包括：(1)課程資訊：提供學習者學習目標及建議學習時間；(2)前言：以第一人稱描述圖書館管理問題來引起學習者注意，並喚起先備經驗；(3)課程內容：以講述方式，搭配圖書館實例照片以貼近學習者實際經驗；(4)練習：適時穿插練習題；(5)課程回顧：用以幫助學習者統整及複習課程重點；(6)名詞快譯通：針對課程提到之圖書館相關名詞作解釋；(7)延伸閱讀及參考書目：針對不同單元亦會適時提供延伸閱讀，供學習者自行深入學習，截取部分課程畫面如表 1。

表 1 課程實際完成畫面（以部分課程內容為例）

前言	內文頁	練習題
		

3.4. 實施階段

本階段主要工作為進行全部教材的組裝、上傳至課程平台，以線上教師、線上助教及學員三種角色進行各項功能測試及修正。

3.5. 評鑑階段

本階段包括形成性評鑑、總結性評鑑和確認性評鑑。形成性評鑑邀請四位學科內容專家及二位教學設計專家參與，學科內容專家針對各單元教材內容進行兩至三回合的內容審查；教學設計專家則針對各單元教材的設計與呈現方式進行審查。

總結性評鑑分成兩部份：第一、將製作完畢教材上傳至平台，邀請四位國小教師進行使用者測試，其中有兩位曾受過圖書館學專業訓練，兩位未受專業訓練。期經專業知能者與新

手之使用意見，協助評鑑課程內容以確保教材的實用性。評鑑面向參考教育部遠距教學交流暨認證網（2009）及數位品質認證中心（2009）的課程教材自評表，分五大面向：教材內容與架構、教學設計、媒體與介面設計、操作與導覽及其他(平台課程播放品質和流暢度)，以李克特式 4 點量表評估使用者滿意程度。1 表示非常不同意、2 表示不同意、3 表示同意及 4 表示非常同意。整體而言，使用者測試滿意度總平均分數為 3.42，以教材內容與架構所獲得分數 3.56 最高，使用者 SD1 認為延伸閱讀是很好的學習資源；SD3 則肯定實務性設計，認為本教材對初學者概念的建立有很大助益。而「操作與導覽」分數 3.33 及「其他」面向分數 3.32 最低，經深入訪談後，發現因 Microsoft Producer 2003 所製作的演講式數位教材部分功能較簡易，較難滿足使用者操作需求；後者則因使用者 SD4 家中網路頻寬過低(256k)，故嚴重影響線上課程播放品質，影音和投影片未能同步播放。本研究彙集四位使用者意見，編輯線上課程學員手冊，以利課前指導學員線上平台及課程的操作使用，以減少學員線上學習操作問題的發生。第二、待線上課程結束時，請學員填寫滿意度問卷，內容分別就教材設計、內容、教學方式、線上帶領及平台使用等面向進行調查。

而確認性評鑑的實施時間則俟線上課程結束後 2~3 個月時間，研究團隊實際走訪線上學員任職之學校圖書館，希望透過實際訪談及觀察方式，深入瞭解學員是否將所學遷移至工作環境，以順利解決任職現場所遭遇的管理問題。

4.線上圖書資訊教師專業知能課程實施現況

本線上課程擬進行八週，根據學習內容的複雜度及學習時間長短，分別規劃線上同步與非同步之教學進度表，線上學習活動主要包含三項：「閱讀線上教材」、「非同步案例討論」及「同步線上討論」。目前以進修推廣學分班方式於 98 年 9 月開始招生，報名人數約 55 名，分別來自北、中、南及東部各縣市區域，其中不乏位於偏遠地區國小圖書館業務人員，學員職務亦相當多元，除負責圖書館業務的代理代課教師、閱讀教師、級（科）任教師或設備組長外，亦有校長、主任、實習教師、圖書館志工及對國小圖書館管理有興趣者。

課程進行初期，即有學員感謝有此線上進修，即使位於進修資源匱乏的縣市教師，亦能充實圖書資訊專業知能，學員 st25 提到：「這是我第一次用線上課程學習、第一次使用討論區，對於資源不足的地方而言，內心非常的高興。」；學員 st54 提到：「數位學習真的好便捷，上星期我在台南，星期二我在雲林，現在我在花蓮，不管在哪個方位都不會錯過上線討論、學習課程。真是太好了！這樣再也不怕出遠門而缺課！」學習者修課期間須照學習進度完成每週應閱讀教材，使其對國小圖書館學基本知識有初步認識。為使學員能將所學直接應用於工作場域，在非同步教學活動區規劃多則國小圖書館管理實例探討，期以「問題導向學習」模式(problem-based learning, 簡稱 PBL)引發學習者的互動討論、腦力激盪及合作解決問題。此外，並利用 JoinNet 同步平台安排數次線上同步活動，讓學員透過與教師、同學間的同步互動，即時解決獨自閱讀教材時產生的學習問題，以提升本線上課程之學習成效。

5.結論

本研究開發教材根據專家及使用者評鑑結果做完修正後，以進修推廣課程學分班形式供台灣地區各國小圖書館業務人員在職進修，期探究網路在職進修方式培訓國小圖書資訊教師的可行性，亦期望藉此實徵研究，修正出最適合發展圖書資訊教師專業知能的線上進修方式，以供各縣市相關培訓單位參考。未來，除繼續積極提供一系列課程供相關人員進修專業知能外，兼具培育國小職前教師具備圖書資訊專長，使每位進入教育現場的教師，皆具備完整的圖書資訊知能，以有效經營管理國小圖書館、運用豐沛館藏支援教學、推廣閱讀風氣，提升圖書館利用教育成效。

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Designing a Virtual Item Bank Based on the Techniques of Image Processing

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Abstract: *One of the major weaknesses of the item exposure rates of figural items in Intelligence Quotient (IQ) tests lie in its inaccuracies. In this paper, a new approach is proposed and a useful test tool known as the Virtual Item Bank (VIB) is introduced. The VIB combines image processing theory with the concepts of figural examinations and Computerized Adaptive Testing (CAT). It is believed that this tool will assist in improving traditional figural tests – in terms of solving previous issues relating to item exposure and allows a figural examination to be more easily developed.*

Keywords: Virtual Item Bank, Image Processing, Item exposure, CAT, IQ

1. Introduction

Through their ubiquity and efficacy, the use of computers in testing has become the norm. In effect, computers have largely transformed the way in which testing has been conducted over the years. Computer-Based Testing (CBT) has been adopted both in Taiwan and overseas. Examples of CBT include the On-line Computer Basic Competence Test of High School and Vocational School Students (<http://www.onlinetest.org/>), the Graduate Record Examination (GRE), the Graduate Management Admissions Test (GMAT), and Test of English as a Foreign Language (TOEFL).

In comparison to the CBT, the Computerized Adaptive Testing (CAT) is a more complex form of testing. This is because a CAT system chooses items for a given examinee based upon the examinee's responses to earlier items on the test, as well as estimating one's ability according to his or her responses. As a result of the reduction in both testing time and testing items, many studies have since focused on the application of CAT (Steven & Barbara, 1989; Ho, 2000). Nevertheless, the problems associated with the limitation of items in an item bank still remain unresolved, primarily due to manpower, budget and time constraints.

Figural tests are comprehensive mental ability testing tools for children and the illiterate. However, it is acknowledged that building a figural test can be rather challenging (Cronbach, 1990). There are at least eight figural test development steps, including designing test specifications, editing items, collecting pre-test data, analyzing items' parameters, revising items, selecting an appropriate scoring method, formal testing, and assessing the overall success of the test (Kingston & Stocking, 1986; Cronbach, 1990).

Item exposure rate is one of the most important factors that influences the security of a figural test. The most common way of reducing this risk is to impose a maximum exposure rate (r). Several other methods have also been proposed in line with this aim (Sympson & Hetter, 1985; Revuelta & Ponsoda, 1998; van der Linden & Veldkamp, 2006).

All of these methods establish a single value of r throughout the test.

In this paper, we present a new method, known as the Virtual Item Bank (VIB) method, which creates an item bank with unlimited items. We will attempt to describe the implementation of VIB and test it in a real VIB. In this way, item exposure rate is always 0. Hence, the problems associated with item exposure can be resolved.

2. Literature review

2.1. Computer Figural Testing

Computer-based figural testing has been widely employed across various institutions, such as the Online Testing Center (<http://www.onlinetest.org/>), the center of Applied Psychology at Beijing Normal University (<http://www.bnufr.com>), and commercial web sites like IQTest (<http://www.iqtest.dk/>). These organizations provide useful computer-based figural testing tools and analytical (analysis) tools for researchers. However, only online versions are provided.

Lin (2001) has researched computer adaptive figural testing since 1998. His researches are based on the analysis of Raven's Advanced Progressive Matrices (APM) test structure, besides being responsible for the development of the New Figure Reasoning Test (NFRT). NFRT contains two main systems: the automatic item-generation system and the online testing system. The online testing system based on IRT theory is just an interface for collecting and evaluating the ability of examinees. The point of this study's research is an Automatic-Generation System. Meanwhile, the automatic item-generation system will be discussed in the following paragraphs.

An automatic item-generation system contains an item generation engine and an item generation algorithm. The examinees are college students, and the item-generation engine is mainly based on APM. The engine can automatically generate a specific item with particular content features, and combine different types of geometric figures in a systematic fashion for producing and measuring the item which matches the goal. The purpose of the measurement was to evaluate examinees' reasoning ability on the conclusion (inference on relations) and deduction (inference of relativity) through the figure partition characteristic of the item and manipulation of the relationships between figures in space. An example item of APM is shown in Figure 1.

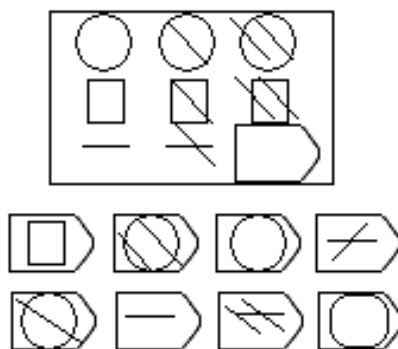


Figure 1. An example item of APM

The algorithm for item-generation was based on the understanding of the analysis of features in APM items. The key points were the parameters in IRT Theory and the problem solving processes of APM.

According to Hambleton and Swaminathan (1985), the ability parameter was set to the average of 0 and deviation of 1, and the difficulty value of the evaluation was set to between -2.0 and 2.0. Based on this criterion, the average difficulty of APM items was -0.868, and between -2.0 to 2.0.

In terms of ability tests, the parameter of discrimination estimated by IRT was usually between 0 and 2.0; the discrimination was better when it was more than 1. Based on this criterion, the discrimination was more than 0 and relatively low in APM, and the item 8 had the lowest discrimination (0.014).

According to the estimation, the supposed value in APM items was 0.219. Since there were 8 choices in APM, the predicated value should be 12.5%. The average guessed value was higher than expected, thus influencing factors should be examined further.

2.2. Content-Based Image Retrieval

In the selection verification, the testers paid full attention to the accuracy of the selection and the difficulty produced by the option. Figural tests were more difficult than text tests. As multimedia technology advances, this study would use data mining to help testers solve the problem of selection verification.

Image comparison has been applied in many fields such as identity authentication, surveillance, human-computer interface, multimedia etc. In this research, content-based image retrieval techniques in image processing would be employed. Also, the main parts of the figure would be identified in order to perform data mining. The concepts and methods of content-based image retrieval are described below:

First the formula without Considering Colour Characteristics: The characteristic vector is used in the computation to represent the figure, as shown below:

$$f^I = (i_1, i_2, i_3, \dots, i_n) \dots\dots\dots (i)$$

f is the characteristic vector of the figure, and n is the code for the content characteristic.

The similarities of two figures are used to compute the Euclidean distance of the characteristic vector (as shown in Formula i). The smaller the value, the more similar the two figures and vice versa.

$$d(Q, I) = \sqrt{\sum_{j=1}^n (f_j^Q - f_j^I)^2} \dots\dots\dots (ii)$$

$d(Q, I)$ is Euclidean distance of the characteristic vector of figure I, Q.

Second the formula that Considers Colour Characteristic: Mehtre, Kankanhalli, and Lee (1998) proposed to consider the figure colour and shape together to calculate the figure similarity. The methods are described as follows.

Step 1: Find the colour clusters in the figure. The formula for the colour distance is shown in Formula iii. While clustering 400 x 400 figure colour, the minimum threshold of the colour distance between each cluster was set to 50.

$$\text{Colour distance} = \sqrt{(\Delta R)^2 + (\Delta G)^2 + (\Delta B)^2} \dots\dots\dots (iii)$$

Step 2: Find the clusters in the figure. In step 1, we categorize colour clusters into layers. In step 2, we mark the shape cluster of each layer, and line up the shape cluster according to pixels in each layer pattern. If the number of pixels in the shape cluster is less than 50, then this shape cluster is omitted. In order to avoid mistaking thin lines for clusters, the minimum density (see Formula iv) of shaper cluster as the shape threshold is set.

$$\text{density, } \rho = \frac{\text{population of Cluster}}{(l_{\max})^2} \dots\dots\dots (iv)$$

$$l_{\max} = \max(\|x_2 - x_1\|, \|y_2 - y_1\|)$$

(x_2, y_1) and (x_2, y_2) are corner points of shape cluster.

Final the Similarity calculation: Using the formula for the colour and shape distance (Formula iv and v), the similarity of the colour and shape can be calculated. Next, use Formula vi to compute the similarity of the two features.

$$coldis(C_i^Q, C_j^I) = \sqrt{(R_i^Q - R_j^I)^2 + (G_i^Q - G_j^I)^2 + (B_i^Q - B_j^I)^2} \dots \dots \dots (v)$$

Figure Q has m colour cluster and p shape cluster. Figure I has n colour cluster and q shape cluster.

$$shpdis(C_i^Q, C_j^I) = \sqrt{\sum_{i=1}^7 (m_i^Q - m_i^I)^2} \dots \dots \dots (vi)$$

i is moment invariant

$$D(Q, I) = \omega_1 \psi_1 + \omega_2 \psi_2 + \omega_3 \psi_3 + \omega_4 \psi_4 \dots \dots \dots (vii)$$

$$\psi_1 = \sum_{i=1}^{\max(m,n)} coldis(C_{c,i}^Q, C_{c,P_c(i)}^I), \quad \psi_2 = \sum_{i=1}^{\max(m,n)} \sqrt{(\lambda_{c,i}^Q - \lambda_{c,P_c(i)}^I)^2}$$

$$\psi_3 = \sum_{i=1}^{\max(p,q)} shpdist(C_{cs,i}^Q, C_{cs,P_s(i)}^I), \quad \psi_4 = \sum_{i=1}^{\max(p,q)} \sqrt{(\lambda_{s,i}^Q - \lambda_{s,P_s(i)}^I)^2}$$

$\omega_1, \omega_2, \omega_3, \omega_4$ are weighted index.

P_c is the closest colour cluster assignment function, and can map every colour cluster i of image Q to the closest colour cluster $P_c(i)$ of image I. Formulas that consider the colour instead of colour characteristics helped generate suitable answers in this study.

3. Methods

This research has developed two research tools: 1. Virtual Item Bank system; 2. CAT system. Both of these two tools have been helpful in the progress of the research. We now proceed to consider system structure and system functions.

3.1. The Virtual Item Bank system

The major functions of this system are to obtain all initial parameters about figural items, and store this data into the VIB. When an examinee takes a test, the VIB will generate suitable items for examinees.

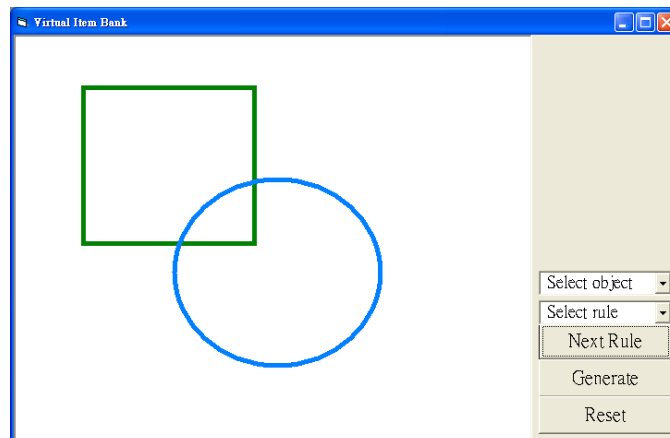


Figure 2. VIB system

3.2. The CAT system:

The major functions of the CAT system are collecting and evaluating the ability of examinees.

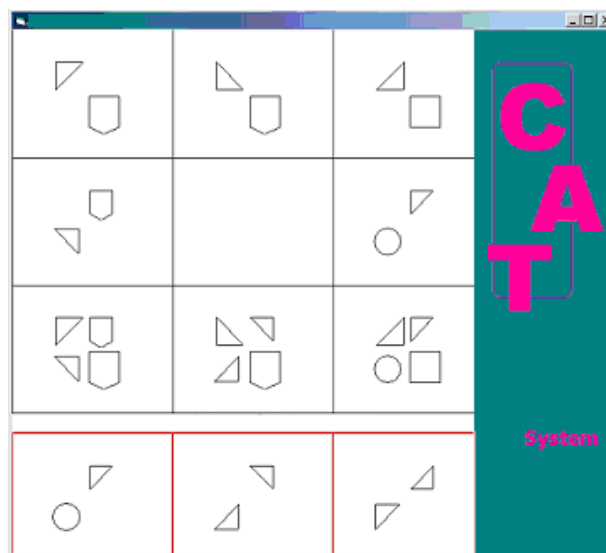


Figure 3. CAT system

The figure above represents a discussion of the problem and demands of item bank generation, in addition to the development of research tools. The research tools helped test editors to solve the problem of the item exposure rate. A simulation of the item overlap rate will be discussed and proved in the following section.

4. Results

4.1. The Item Rule Definition

In this paper, a VIB has been built specifically for figural testing. This VIB contains 48 rules. Each rule is composed of an image processing operation and a problem-solving process.

4.2. Parameter Estimation

The primary parameter of this study was item difficulty parameter. An experiment deploying an online CBT system was designed to collect and estimate the items created by the VIB. In this experiment, 310 elementary school students were the subjects. The results of this experiment are presented in table 2. The structure of the CBT system and the results of the estimation are discussed in the following paragraphs.

An online CBT system is use to collect data of the item-generation rules in the VIB. An instruction example of this system would show to examinees before testing start. When examinees finished the test, the results would be transfer to the server and be analyzed in a short time.

Table 1. Difficulty parameter estimations of item generation rules

D1	Difficulty	D2	Difficulty	D3	Difficulty	D4	Difficulty
1	0.21	13	0.46	25	0.21	37	0.65
2	0.56	14	0.44	26	0.39	38	0.4
3	0.49	15	0.49	27	0.4	39	0.63
4	0.08	16	0.71	28	0.48	40	0.35
5	0.8	17	0.27	29	0.22	41	0.34
6	0.12	18	0.22	30	0.83	42	0.43
7	0.4	19	0.19	31	0.29	43	0.42
8	0.39	20	0.31	32	0.72	44	0.65
9	0.4	21	0.83	33	0.7	45	0.61
10	0.27	22	0.27	34	0.6	46	0.6

11	0.34	23	0.76	35	0.63	47	0.6
12	0.4	24	0.45	36	0.6	48	0.51

D1 : Item generation rule are composed of SUB operation and 12 processes

D2 : Item generation rule contains OR operation and 12 processes

D3 : Item generation rule are consisted of AND operation and 12 processes

D4 : Item generation rule are composed of XOR operation and 12 processes

The item difficulty parameters created by the same rule were closed to each other. The results of the experiments are described as table 2.

Table 2. Results of item difficulty parameters generated by the rule A, B, C

Rule A	Difficulty	Rule B	Difficulty	Rule C	Difficulty
A-1	0.63	B-1	0.5	C-1	0.28
A-2	0.69	B-2	0.5	C-2	0.39
A-3	0.67	B-3	0.56	C-3	0.41
A-4	0.7	B-4	0.53	C-4	0.38
A-5	0.73	B-5	0.59	C-5	0.34
A-6	0.72	B-6	0.52	C-6	0.16
A-7	0.72	B-7	0.52	C-7	0.25
A-8	0.64	B-8	0.59	C-8	0.42
A-9	0.81	B-9	0.59	C-9	0.34
A-10	0.72	B-10	0.48	C-10	0.38

Table 3. Standard deviation of rule's difficulty parameters

Rule A	Rule B	Rule C
0.051218	0.04158	0.082226

The VIB would also generate items with similar item difficulty parameters by the same rules. According to these two results, we can define the parameter of CAT System. We can further prove that items generated by the same rule had approximately the same parameter. These results indicate that the VIB is a powerful tool, and it can solve the problem of item exposure.

4.3. The Item Overlap Simulation

In this study, an item overlap simulation has been used to prove this system. According to the item Overlap rate (given in) formula ix, when max length of the test = 48, subjects = 30000. The simulation results are as follows.

Table 4. Results of the item overlap rate simulation

Item overlap rate (R)	2.43488E-10
Mean of test length	36.5078
Mean of Theta-Estimated	-0.106
Mean of SE	0.4023

5. Conclusion

From the results of item overlap simulation, it is obvious that there is no problem for this system with item exposure. Every examinee got different items on the same test (run).

This characteristic allows the VIB to be used not only in measurement but also in practice. The results of the experiment showed its evident effects in practice.

In the VIB, the item was generated dynamically. It was however difficult to apply it in the CAT system. In order to solve this problem, two CBT testing systems were designed to collect the item difficulty parameters of the item generation rules. Table 3 and table 4 demonstrate that the items generated by the same item generation rule have approximately the same item difficulty parameters.

These results show that a CAT system can contain a VIB; however, there are still many different type of tests needed to be analyzed which will be the focus for the future work of our research.

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Teachers' Epistemic Positions and their Online Interactions

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Abstract: *This study investigated seven teacher's epistemic beliefs about knowledge and knowing. These teachers were recruited from three in-service courses that were designed based on the pedagogical principles of the Knowledge Building Community. A Computer-Supported Collaborative Learning (CSCL) environment entitled Knowledge Forum (KF) was employed to support the courses. Interviews with the teachers provided us with information about their epistemic beliefs. The teachers' epistemic beliefs were ranked based on the stages of epistemological development and they were compared with the patterns of online participation and knowledge building discourse that were captured in the Knowledge Forum. The findings indicate that the developmental epistemic positions that the teachers held seem to be related to their participation behaviors and the depth of discussion exhibited in the knowledge building environment.*

Keywords: Epistemic beliefs, computer-supported collaborative learning, in-service teacher

1. Introduction

Research on the use of technologies in education has been focusing on issues like teacher's confidence, ICT competencies and resistance to change (BECTA, 2004). A critical factor that has been neglected is that of teacher's epistemic beliefs, which could influence how teachers teach and learn, and this will in turn have an impact, directly or indirectly, on the students they teach (Schraw & Olafson, 2002). As technology advances, it is necessary for educational researchers to study different epistemological stance demanded by the technology for productive learner's engagement (Mason & Boldrin, 2008). This study contributes to current literature by studying the epistemic challenges teachers face when they venture into a Computer-Supported Collaborative Learning (CSCL) environment.

2. Literature Review

Epistemic beliefs are beliefs that an individual holds with regard to the nature of knowledge, the source of knowledge and the justification of knowledge (Hofer & Pintrich, 1997). Perry's (1970) research identified several developmental stages of personal epistemic beliefs, which were supported by later research works (Belenky, Clinchy, Goldberger, & Tarule, 1986; King & Kitchener, 1994). We summarized these stages in Table 1.

Table 1. Developmental Stages of Epistemological Beliefs

Epistemological developmental stages	View on knowledge	Source of knowledge
Dualist/ Objectivist	Knowledge are certain	Experts and authorities
Multiplist	Most knowledge as certain	Experts and authorities
Relativistic	Most knowledge as evolving	Reliance on self
Committed relativist/ Evaluativist	Knowledge as evolving and contextual	Self as source of knowledge through some forms of justification

Studies that investigate practicing teachers' epistemic beliefs have been rare (Schraw & Olafson, 2002), in particular, there is a lack of studies on how practicing teachers' epistemic beliefs would enable or constrain their learning in an ICT-enriched professional development context. As beliefs tend to affect learning behaviors (Richardson, 1996), an investigation on teachers' beliefs and how it affects their professional development is an essential area to explore.

The Knowledge Building Community (KBC) proposed by Scardamalia and Bereiter (1996) was adapted in this study in order to facilitate teachers' professional development in implementing ICT enriched constructivist pedagogy. This model demands users to function as knowledge constructors in collaboration with other participants. Key principles that underlie it include working with authentic problems and treating all ideas as tentative and improvable. Participants are required to assume epistemic agency in identifying the problems and refine initial ideas through collective cognitive responsibility and constructive use of authoritative resources. KBC is social constructivist in orientation and its focus is on knowledge creation instead of knowledge acquisition, hence, different demands are placed on the participants' epistemological stance. How students and teachers' epistemic beliefs would affect their functioning in a KBC has not been studied, as noted by Bereiter and Scardamalia (2006).

To contribute to the research gap identified in the literature review, the following research questions were generated to help focus the study: (1) What is the relationship between the teachers' epistemic beliefs and their pattern of participation in the online discourse?, and (2) How is the teachers' epistemic beliefs related to the depth of interaction?

3. Methods

This is an exploratory case study with a focus on seven participants who were selected through convenient sampling. The seven participants, aged between 27 year-old to 38 year-old, were a group of teachers attending three professional development courses on Instructional Technology. These teachers had teaching experience ranging from 3 to 9 years and all of them were teaching at the upper elementary levels (4th to 6th grade). For confidentiality, the following fictitious names are used: Wah Han, Siti, Kai Xin, Xiao Shi, Intan, Farhati, and Harfizah. Wan Han was a Head of Department and Siti was a library and ICT coordinator; the other five participants did not assume any leadership positions in their schools.

3.1. Context of the Study

Three modules from Advanced Diploma for ICT course had been redesigned in accordance with the principles of the KBC. The modules were conducted in a blended environment where 50% of the sessions occurred in a face-to-face setting and the other 50% in an online setting. Through the three modules, the teachers identified authentic problems that they have faced in designing ICT-based lessons and co-construct lesson ideas for implementation. They improved each other's lesson ideas by sharing relevant resources and teaching strategies. The other aspect of the course was the

online discussion about key ideas revolving around ICT integration and the used of ICT as Mindtools (Jonassen, 2000). The first author was the facilitator for all the above-mentioned modules.

3.2. Data Collection and Analysis

The seven teachers were interviewed at the beginning of the course. Each interview session lasted for an average of 50 minutes. Semi-structured interviews with questions adapted from Brownlee's (2004) study were employed. This form of interviews was chosen to provide some foci without depriving the teachers and researchers the chance to follow up on pertinent issues. Examples of the interview questions include: "Some people think that scientist can ultimately discover the truth. What do you think about this statement?", "What about the statement 'Today's truth maybe yesterday or tomorrow fiction'?", "In learning about something that you really want to know, what is the role of an expert?", and "Do you agree when someone says that there are no right answers and anybody's opinion is as good as another's?"

Analysis of the transcripts was carried out based on Flick's (2002) recommended strategies of thematic coding. To enhance the trustworthiness of the study, all transcripts and the researchers' interpretations were sent to the teachers for member checking. As there are only seven participants, the researchers choose to present their assessment of the participants' epistemic position to two other interested colleagues and they agreed with the researchers' assessment. Besides the interviews, the teachers' online posts were also collected for content analysis. Computer log files were obtained through submission of the KF database to the Analytic Toolkit®, which generates basic measurements of participation. In addition, to provide a comprehensive measurement for participation, data was collected on the frequency of note reading, writing, and words count.

Gunawardena, Lowe and Anderson's (1997) Interaction Analysis Model (IAM) was adopted to assess the depth of the teachers' interaction. IAM model was chosen for it is founded on social constructivist theories which are consistent with the KBC. In addition, it is also one of the more reliable and user-friendly models available (Marra, Moore & Klimczak, 2004). All posts were coded based on the model reported by Chai and Khine (2006) in an earlier study. Inter-rater reliability for the coding within the same phase code was 0.78. Table 2 shows the main phases of IAM:

Table 2. The Five Phases of Interaction Analysis Model

Phase 1: Sharing/Comparing of Information
Phase 2: Discovering dissonance, gaps in understanding or areas for improvements among ideas or concepts
Phase 3: Negotiation of meaning/ co-construction of knowledge
Phase 4: Testing and modification of proposed synthesis or co-construction
Phase 5: Agreement statements/ application of newly-constructed knowledge

Based on the phase codes generated, an index labeled as Mean Interaction Depth (MID) was created. MID is a weighted mean to indicate the average level of interaction that the participant is engaged in.

$$\text{MID} = [\text{Sum (no. of posts in phase } n \times n) \text{ for } n= 1 \text{ to } 5] / \text{Total no. of posts.}$$

For example, a participant who has 30 posts may have 15 posts rated as phase 1 and the other 15 as phase 2. The MID is thus the mean of $[15 (\text{posts}) \times 1 (\text{phase}) + 15 (\text{posts}) \times 2] / \text{total number of posts}$.

4. Results and Discussion

To answer the first research question, it is necessary for us to look at the teachers' epistemic beliefs and their participation patterns in the online forum.

4.1. Epistemic beliefs of the participants

All seven teachers from the study seemed to hold relativistic epistemic beliefs. None of the teachers was in the stage of the dualistic beliefs that regard everything as either right or wrong. The teachers are well aware that truth is constantly evolving and claims of knowledge can be changed with the discovery of new evidence. For example, Farhati reported that scientific are what scientists “have constructed but not necessarily the truth”. Xiao Shi viewed what is accepted as truth is only valid for now.

While the teachers hold relativistic view about knowledge, their position in the dimension of knowing seems different when considering their level of consciousness about epistemological issues and their views about themselves as knowledge constructors. It seemed that Harfizah and Farhati were in the multiplicity stage. Both teachers explicitly stated that they had not consciously considered epistemological issue prior to the interview. As a learner, Farhati commented in one of the interviews that she did not believe that she has ever constructed knowledge. Farhati seemed to classify knowledge construction as an activity performed by experts in some field rather than a way people come to know. The role of expert for her is people “who knows” and can “pass on what they know” to people who desire the knowledge that they know.

Harfizah responded in a similar manner and disclosed that she has been accepting “facts” unquestioningly, when she was asked about how she could determine if a person is an expert or not. Her response was that she has “never thought of that” and that she saw “knowledge as the textbook stuff. Whatever the students have to learn, that is the knowledge that you have to give, to pass on.” It seems clear that Harfizah rely more on authority as the source of knowledge although she is aware that knowledge is evolving.

Comparing to Farhati and Harfizah’s reports, the other participants seemed to project a stronger sense of self as a knower. For instance, when Intan described the role of experts in her learning, the authority of experts seemed to be less emphasized and the importance of the self as a knowledge constructor was brought forth as “You cannot gain what you want to know solely from experts. You still have to find out more... you look to them (experts) like some sort of guide.”

Similarly, when confronted with the situational question about experts disagreeing with each other, Xiao Shi gave a rather direct and subjective response: “I believe what I believe.” This indicates that like Intan, Xiao Shi recognized the importance of self as an epistemic agent. Both Xiao Shi and Intan projected “subjective knowing” (Belenky et al., 1986) as their way of dealing with controversial situations. Kai Xin seemed to be more objective in that she would evaluate competing claims “base it on evidence” that are generated through experimental studies. Such response, according to Belenky et al.’s (1986) scheme, would be categorized as procedural knowing.

Like Kai Xin, Siti and Wah Han also seemed to adopt an evaluative epistemological position. Knowing, for Siti, was not a matter of receiving knowledge from the authority but a result of pursuing her interest and building “upon the prior knowledge” and “everyday life experiences”. Everyone is entitled to the claim of knowledge. As for Wah Han, due to a conversion in religion from Christianity to Islam, he had carefully considered several philosophical issues. When the researcher interviewed him on the attainability of scientific truth, he decidedly said that “they can never”. However, he is also quick in qualifying that while objective truth is not attainable, it does not mean that any opinion is as good as another. He gave an example “numbers are infinite does not mean that the calculators cannot be used. You just have to test one plus one plus one and the answer is three.” He also explain the contextual nature of knowledge by giving the example that an oncologist having cancer, which is deem to be bad by most people, could be good in that when s/he recover, the experience would make him/her a more understanding doctor.

In summary, the seven participants in this study seemed to hold a range of epistemic beliefs with Farhati and Harfizah at the multiplicity stage and the rest at the relativist stage, where Kai Xin, Siti, and Wah Han responded with indications of an evaluator’s stance. Although the sample size of this study was small, the distribution seemed to parallel Brownlee’s (2004) study where most teachers were at the relativist stage and none were holding the naïve view that knowledge is certain. Based on our analysis, we ranked the epistemological developments of the teachers in the

order of Wah Han (1), Siti (2), Kai Xin (3), Intan (4.5), Xiao Shi (4.5), Farhati (6), Harfizah (7). As we could not distinctly distinguish Intan and Xiao Shi's positions, they were assigned 4.5 in the rank order.

4.2. Participation in online forum

Studies done on the effect of epistemic beliefs on learning have indicated that sophisticated epistemological outlooks are generally associated with deeper and better learning at school children's level (Schommer, 1990). Beliefs also influence how and what teachers learn when they are learning to teach (Richardson, 1996). Table 3 shows the teachers' participation patterns in terms of the number of notes posted, words written and notes read. These three forms of participation were ranked and a mean participation score was obtained upon adding the ranks. Based on the participation scores, the participants were then ranked in terms of how actively they participated in the online interaction.

Table 3. *Participation Rate of the Teachers in Knowledge Forum*

Teacher's Pseudonym	Total number of notes posted	Words written	Percentage of notes read	Ranked Participation	Ranked Epistemological positions
Wah Han	65	9401	73%	4	1
Kai Xin	114	12926	79%	2	3
Xiao Shi	88	7099	43%	5	4.5
Intan	71	8371	86%	3	4.5
Farhati	40	4678	45%	7	6
Harfizah	53	6488	40%	6	7
Siti	194	22452	98%	1	2
Mean/teacher	89.3	10202	66.3%		

The rank-order of the teachers' epistemological profile and their ranked participation were correlated and a Spearman correlation of 0.72 ($p < .05$) was obtained. This suggests that to a certain extent, the teachers' participation pattern in KF (in terms of the number of words written, number of notes posted and the percentage of notes read) is moderately correlated to their epistemological profiles. Hence, there is a relationship between the participants' epistemic beliefs and their learning behaviors in an online environment.

From the interview, some participants' involvement was impeded by circumstantial factors such as family commitment (Farhati) and illness for two to three weeks (Harfizah). Compared with Wah Han's situation who is a Head of Department and a father of three, it seemed that Wah Han's schedules were tighter and yet he was more active. Beside, Siti also has a larger portfolio in school than Harfizah and Farhati. As such, to attribute the differences in participation as solely due to circumstantial factors is not seemingly an adequate explanation. There is a possibility that the teachers' epistemological stance, especially their confidence as a knower may affect their participation level. This is a central issue because if the teachers themselves cannot participate productively in a CSCL environment due to their epistemological positions, it may be difficult for them to help schoolchildren in doing so. More extensive research is definitely needed to verify this claim.

4.3. Teachers' epistemology and depth of discussion

To understand the relationship between the teachers' epistemological and their depth of discussion, the teachers' messages were coded using IAM. Below are the results (Table 4).

Table 4. *Mean Interaction Depth of the Teachers' Online Discourse*

	Wah Han	Siti	Farhati	Harfizah	Kai Xin	Intan	Xiao Shi
Phase 1	31	79	24	38	58	40	60
Phase 2	6	42	5	9	19	18	12
Phase 3	12	54	5	4	21	11	8
Phase 4	10	10	2	0	13	0	6
Phase 5	6	9	4	2	3	2	2
Total	65	194	40	53	114	71	88
Mean Interaction Depth	2.14	2.06	1.88	1.47	1.87	1.68	1.55

From the above results, the ranked MID was again correlated with the teachers' epistemological positions and a score of 0.78 ($p < .05$) was obtained. It seems thus, the teachers' epistemological stance is also related to their depth of interaction in the online platform. Gunawardena et al. (1997) have posited that phase 1 interactions are largely confined to information sharing and knowledge co-construction begins from phase 2. Based on the results, most of the participants seem to be at the stage of sharing information with Wah Han and Siti progressing to the stage of knowledge co-construction. This preliminary finding provides some insight into how epistemic beliefs assessed from the developmental perspective may impact learners' online interaction in a KBC. It is noteworthy that although Wah Han and Siti are assessed as being at the peak of epistemological development, their MID is only at stage 2, indicating that they may also need further scaffolding in the knowledge co-construction processes.

5. Conclusions

Teachers play critical roles in implementing new pedagogies with technologies. While much effort has been devoted to issues like technological competency of teachers, time availability and logistic, teachers' epistemic belief is a latent factor that may have a deep impact on the ways they learn about new pedagogies and subsequently the ways they implement the pedagogies. Our exploratory study has shown that during the professional development of teachers on knowledge building approach, teachers with evaluativistic profiles participated more actively in online discussions compared to those with multiplist profiles. Circumstantial constraints did not seem to be a strong competing factor to explain the behavior. Perhaps what is more imperative is that the teachers with evaluativistic profile have demonstrated greater depth in the knowledge construction level during their discussions. We would like to propose to advance this research in the following ways: (a) verify the results with larger sample of teachers, (b) study how their beliefs translate into practices in classrooms and how this might affect the students under their charge; and (c) investigate ways to change the teachers' epistemic beliefs if necessary.

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台灣資訊教育政策新聞報導之批判論述分析

A critical discourse analysis of news reporting about Taiwan's ICT education policy

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【摘要】本研究旨在透過 Fairclough 取向的批判論述分析(critical discourse analysis)，以對台灣資訊教育的政策文本和改革論述、論述過程和其中所蘊含的知識/權力關係、形成背景和時代脈絡，有所理解、揭露和釐清，進而能對未來的改革方向，提出一些可資反思和參考的依據。

【關鍵詞】 資訊教育、教育政策、批判論述分析

***Abstract:** Using Fairclough's approach of critical discourse analysis (CDA), this paper aimed to understand the policy texts and the reform discourses, expose the discourse process and the relation between knowledge and power within it, as well as clarify the background and the context of the ICT education policy in Taiwan. After that, this paper offered some advices or suggestions on the future reform.*

Keywords: ICT education, education policy, critical discourse analysis

1.前言

自 1980 年代以來，社會科學領域的學者們就對社會中存在的語言或論述 (discourse) 投入大量的心力，努力釐清語言機器是如何透過權力來加以運作；於是，論述分析 (discourse analysis, DA) 日漸成為重要的學術思潮。身為論述分析的途徑之一，批判論述分析 (critical discourse analysis, CDA) 關注社會現實中的不公不義以及論述呈現權力與意識形態的方式，同時致力於挖掘改進這種不平等的方法，在其發展過程中也逐漸形塑出跨學科性、多樣化分析模式及廣泛關注社會面向的特點。最近，CDA 也被開始應用於資訊教育政策領域。Brooks (2009) 透過 CDA 分析加拿大 Alberta 省教育部一篇名為〈學校擴展科技使用來轉化學生的學習機會〉的新聞稿，將其視為科技政策文本鏈的一部分，揭露在 Alberta 省教育科技政策計劃之下，廣泛使用科技背後的潛在原理。本文也是屬於此類的新嘗試。

2.理論架構：N. Fairclough 的批判論述分析觀點

CDA 的興起是 1990 年代以來論述分析最重要的發展，但是，CDA 在眾多學科中卻有各式各樣的取向。Taylor (2004) 特地指明英國學者 Fairclough 的 CDA 是適合用於批判的政策分析，因為他提供一種有系統的分析架構，允許在細節上調查語言和其他社會過程的關係，以及語言如何在權力關係中運作，讓研究者能夠超越猜測和證明政策文本是如何運作。此外，Fairclough 關注揭露權力關係的論述建構，致力於進步的社會改革，故本文也採用之。

Fairclough 取向的 CDA 建立在一個三維分析架構，是將論述事件 (discourse event) 分成：文本 (text)、論述實踐 (discursive practice) 以及社會實踐 (social practice) 等三個同時存在的面向，也發展出描述 (description)、詮釋 (interpretation) 和解釋 (explanation) 等分析方法。其分析重點在於：以描述分析文本的語言學特徵；用詮釋論述實踐過程與文本間的關係，側重於文本生產、分配和消費的過程；再用解釋來分析論述事件所屬的廣大社會實踐，

包含不同的論述實踐如何透過霸權及意識型態來形塑社會，以及如何被社會所形塑（Fairclough, 1992）。其架構如圖 1 所示。

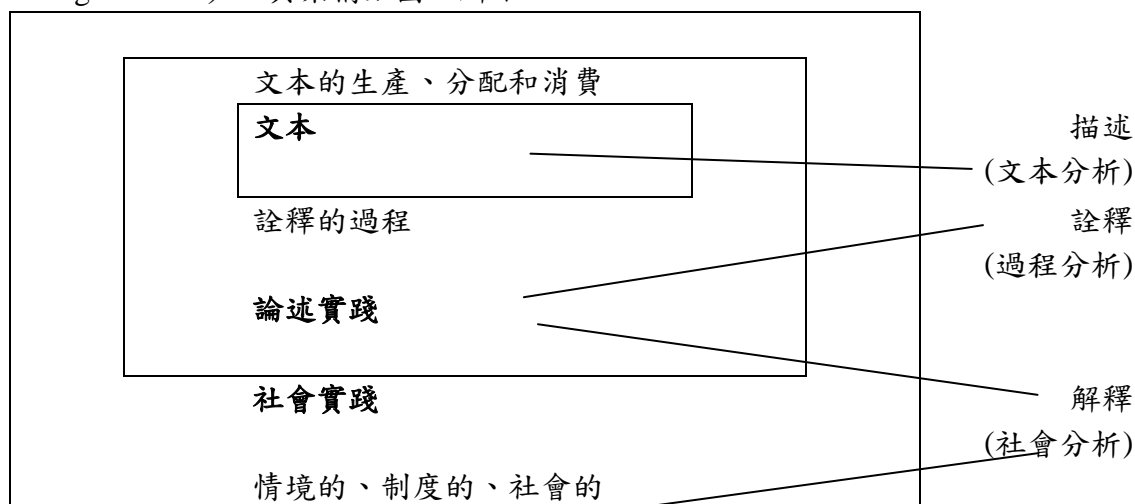


圖 1 Fairclough 批判論述分析架構 (Fairclough, 1995: 98)

簡言之，本研究欲借用此為理論架構，以台灣媒體對於教育部 2008 年頒佈《資教白皮書》（教育部，2008a）之相關報導為分析題材，圍繞在「描述—文本分析」、「詮釋—過程分析」與「解釋—社會分析」三個向度，探討台灣資訊教育政策如何充分執行於相關的論述實踐之中，進而達到什麼樣的論述效果。

3. 研究步驟

2008 年 8 月 17 日，教育部公布《資教白皮書》，就資訊教育現況整體加以檢視，並規劃 2008 至 2011 年資訊教育願景。然而，隔天相關媒體的報導卻不太一樣，有的標題是「2011 年每 5 學生有 1 電腦」（楊惠芳，2008），有的則是加入其他國家資訊教育政策資料，評析出「中小學 e 化落後美日星」（黃以敬，2008），讓教育部大為緊張，電算中心韓善民副主任趕緊回應「資訊教育除了電腦數量，更重要是強化軟體學習」（陳映竹，2008）。

在譚以敬（2003）對 2002 年教育政策相關新聞報導的分析研究中發現：台灣的主流媒體對教育政策新聞報導著重在公共事務的宣導說明，報導中多呈現教育部已決定推動某項政策，此時的教育政策新聞僅係教育部透過媒體達到公告週知目的，隱含有為官方訊息傳遞與代言的意味。本案出現難得一見的火花，是選取做為分析樣本的主因。

其次，本研究參考賀政（2008：45）修改 Fairclough（1992：73）CDA 三維分析觀點而提出的，針對前述《資教白皮書》相關報導進行底下的逐項檢驗：報導包含哪些內容？報導包含哪些消息來源或被報導者？消息來源的意見有無被完整呈現？哪些消息來源特別受到重視或被忽略？標題或導言強調哪些內容或面向？報導對事件、消息來源或被報導者做出何種解釋與建構？事件被置於何種社會情境中？報導為何有如此的論述建構？影響論述的社會環境因素為何？為何報導會明示或暗示某種立場？報導中為何如此替事件做出歸因？

4. 研究結果

4.1. 「科技設備的接近取得及使用」似是資訊教育政策重點

以楊惠芳（2008）的報導為例，在「文本層面的描述」部分，報導內容著重於教育部未來要推動的政策內容，教育部電算中心是其消息的來源，而訂定這本《資教白皮書》的團體並沒有發言談論如何召開會議、蒐集到哪些意見、又如何處理各界意見。教育部電算中心成為本篇報導的唯一發言者，也顯示教師與學生在《資教白皮書》相關報導中是隱身的。

在「論述層面的詮釋」部分，標題為「2011 年每 5 學生有 1 電腦」，而在《資教白皮書》七項預期達成指標中（教育部，2008a：25），本篇報導在首段提到指標 2、4 與 5，末段提到指標 3 與 7，這五項被報導的指標中，有三項是與資訊教育基礎硬體建設有關。另外，被遺漏報導的指標 1 與 6，剛好是在資訊教育中屬於課程與教學的軟體面向。由此可見，資訊教育的硬體建設才是報導關注的焦點，且標題正是使用指標 4，更強化硬體建設是推動資訊教育應被重視且不斷改進的觀點。對硬體建設的強調，使得購買設備、提升生機比（學生與教學電腦的人機比）被形塑為解決資訊教育問題的答案。

最後，在「社會文化層面的解釋」部分，《資教白皮書》提出的時間距離前一次教育部投入經費採購電腦教學設備剛好相差四年。2005 年，行政院核定經費 5.34 億元，教育部又自籌改善偏遠地區資訊教學環境經費 2.7 億元，兩者合計約 8 億元經費，辦理資訊設備逐步更新，預計四年完成電腦設備更新。也就是說，到了 2008 年又有教學電腦屆齡需要更新了。因此，《資教白皮書》應該被置於因應財政/預算計畫所需要的政治背景下來考量。在國家財政狀況困窘，預算往往有排擠效應的情況下，有一份可以突顯自身業務必要性、急迫性、合理性、可行性的政策文件，應該是教育部電算中心所樂見的。因此，可以看出資訊教育政策的制定往往是以爭取預算需要為出發點。而預算爭取到位後，受益的除了有各級教育單位，也還有各大資訊廠商。

這一點，可以在 2009 年的「振興經濟新方案---建置中小學優質化均等數位教育環境計畫」中一覽無遺，相關採購項目皆在《資教白皮書》中提及，有些項目更是比《資教白皮書》提早時程完成（教育部，2009）。甚至，教育部次長也直言：面對全球這波經濟不景氣，資訊應用力就是國力，國內學生人數減少，各級學校資訊設備必須更新，用最好設備改善下一代教學環境，希望這波設備投資十萬火急，可為國內資訊業帶來活水」（李若松，2009）。所以，在推動資訊教育政策背後，也與經濟發展、解決資訊產業需求息息相關。

4.2. 資訊教育政策是追求沒完沒了的數字遊戲？

就教育部與自由時報對《資教白皮書》的爭論來看，自由時報在「文本層面的描述」方面，記者黃以敬（2008）標示是「新加坡、台北採訪報導」、引述「新加坡教育部長黃永宏」及「全球微軟公共教育事業部門亞太區總監 Vincent Quah」的談話、援引「新加坡教育部『第三代資訊教育總藍圖』」，消息來源較多，也似乎要證明自己的講法有所本。不過，標題雖顯示「落後美日星」，文中卻未交待美日兩國的資料來源，也沒有提及日本的狀況，卻在標題直陳「落後日本」；反之，報導中有提到韓國的人機比，但在標題中卻又未提及韓國？

在「論述層面的解釋」部分，黃以敬（2008）幾乎鎖定在「五人一機」與「一人一機」這件事情的對照上面，連段落小標題已經寫成「我資訊課時數增至 36 節」，但是，段落內文還是著重描述「台灣在資訊教學的投資建構明顯落後」。不過，自由時報還是有呈現教育部電算中心的回應，可算是盡到平衡報導之責。

在「社會文化層面的詮釋」部分，近年來國內對於教改討論不乏國際競爭比較的觀點，此篇報導的記者不同於國語日報記者，還會利用其他國家數據來針貶教育部的政策，而這往往也是吸引民眾關心的焦點。不過，該名記者也似乎沒有查明若干措施背後的政經因素。文中提及的「未來學校」，基本上是「微軟公司」的構想，其試圖影響亞太地區國家教育政策的背後，也應與想維持該公司的商業利益有關。文章以微軟公共教育事業部門亞太區總監的話為結尾，也可以反應資訊教育政策面臨更強大的國際化或全球化影響。

而陳映竹（2008）的報導算是教育部的另一種回應心聲。相較於本研究對楊惠芳（2008）、黃以敬（2008）的分析，認為教育部往往以對硬體建設的強調，來形塑資訊教育的走向；此處，教育部改以「吃軟不吃硬」來回應自由時報的質疑，「軟體更重要」的聲音儼然可以成

為救火隊。問題是，在《資教白皮書》48 項行動方案中，有幾項是與「強化軟體學習」有關？對照 2009 年通過的「建置中小學優質化均等數位教育環境計畫」，也幾乎與此無關。

5.研究結論：再以 Cuban 觀點檢視台灣媒體的資訊教育政策論述

根據前述的分析，顯然台灣社會仍普遍存有「增加電腦的可得性，將增加使用性，也會促進有效教學及良好學習」的假設，不但政策制定者相信這樣的論點，媒體也以此來檢驗、評估政府的投入程度。但是，套用 Cuban (2001) 的質疑，政府花費龐大資金投入學校科技設備，增加接近取得，能夠確保教學就是否隨之轉變？政府部門期望投入經費，是否因能在短期內藉由統計數據明顯的出現成效、彰顯政績，於是更加用力維護獲得預算的支助？而且，別忘了當政府為學校創造出更多接近取得新科技的過程中，也存有在某種微妙的關係：誰在學校市場中販售科技設備以獲取利益？是不是相關利益者助長乃至加速學校科技改革的速度與循環？這一連串決策背後是否顯示政府與媒體皆是認同學校改革應走向商業模式，改革者購買科技軟硬體設備成為一種象徵性的政治表態 (symbolic political gesture) ？

如果要避免資訊科技成為政策的象徵行動，也避免僅以簡單的生機比數字來做為資訊教育政策成功或退步的論述，以混淆了學校發展資訊教育的目的，我們可以進一步參考 Cuban (2001) 的建議：分析、明辨科技改革的動力來源，做出適當的判斷及合理的解釋，必能使科技發揮功效，科技仍具有在教育現場實踐的可能性。

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國小六年級資訊課程實施同儕教學之研究

A Study of Peer Tutoring Strategy applied on the Information Curriculum of 6th Graders

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【摘要】 在當前國小資訊教育中，教師常需針對學生的技能操作問題親自指導，往往受限於時間壓力而無法提供即時的協助與解答，且易於造成進度的延遲。本研究以國小資訊課程「影像處理軟體應用」為例，導入「同儕教學法」，採用「準實驗設計」比較「同儕教學模式」與「傳統教學模式」對國小學生「學習成效」、「電腦態度」、「自評、互評成績」之差異，以及探討實驗組學童進行「同儕教學法」後對於「同儕教學之感知與態度」。藉由此研究評估此模式於教學的效益與實用性，期能在電腦課程中達成更佳的教学效果。

【關鍵詞】 同儕教學、資訊教育、學習成就、電腦態度

Abstract: The main purpose of this study is to adopt peer tutoring strategy in the information curriculum, and to conduct a quasi-experiment for comparing the difference of learning effect, computer attitudes, and self- assessment and peer-assessment between peer-assisted learning mode and traditional instructional mode. The subjects are 148 6th graders in Taipei city, and the learning unit is the application of image processing software. The experiment group accepts an inventory of perception and attitude toward peer-assisted strategy after experiment. The result will be valuable for elementary information education when applying on the peer tutoring strategy.

Keywords: peer tutoring, information education, learning effect, computer attitude

1. 緒論

在國小資訊課程中，大多數資訊教師是採用講述式教學法來進行教學，講述式教學是以教師為中心（teacher-centered）的教學法，學生實作時也是由教師進行糾正學生在操作過程中的錯誤。這種方法有其優點，可讓教師了解每個學生的進度與程度，但在每班人數高達 25 人甚至更多的班級時，教師往往無法顧及每個學生的問題，並可能影響到班級的學習進度。本研究以資訊教育工作者的身份及經驗，發現上述的教學問題，期運用同儕教學策略以改善電腦課程之教學困境，透過同儕教學減少傳統式教學法的缺點並進而提昇學生的學習興趣與態度。

2. 文獻探討

2.1. 同儕教學 (peer-assisted tutoring strategy)

同儕輔助學習策略是由 Fuchs (1997) 提出，在同儕相互平等互惠的狀態下，於學習過程中幫助同儕學習以達到教學鄉長的目的，且適應不同程度背景學生之學習需求 (Fuchs, Fuchs & Burish, 2000)。Topping (2000) 認為運用同儕學習的目的，是希望學習者透過與傳統教師講述教學不同的學習方式，包括同儕間的合作、教導、模仿、觀察、評量等策略，藉以改善行

為，提升學習能力。Fantuzzo, Heller 和 Reilly (1984) 認為同儕教學是運用同儕間的相互幫助、彼此討論課業、分享學習經驗及紓解學習焦慮。

2.2. 同儕教學理論基礎

「社會互賴論」認為團體的本質是團體成員們基於共同的目標而產生的互賴。社會互賴論主張積極的互賴-合作，進而產生互相幫助、有效溝通、建設性的處理衝突，並且彼此信賴等行為（黃政傑、林佩璇，1996）。「認知發展論」中，維高斯基（L.D.Vygotsky）提出「潛在發展區」（the zone of proximal development）和「鷹架」（scaffolding）的觀點，認為個體知識的獲得具社會性，經由同儕間的學習、理解及解決問題建構而成的（黃政傑、吳俊憲，2006）。

2.3. 國小電腦課程教學問題

王全世（2000）指出由於每週電腦課程時間有限，當學生提出的問題過多時，老師無法完全解決學生軟體操作的問題，會導致學生偏離學習活動。如果老師在電腦課程中指導的學生太多，則某些學生必須浪費時間等待新的教學內容，亦會延誤上課的進度（林立斌，2006）。

3. 研究方法

3.1. 研究設計

本研究採準實驗設計之「不等組的前測—後測控制組設計」。同儕教學模式部份，本研究採「同儕輔助學習法」（Peer-Assisted Learning Strategies, PALS）之教學模式，採異質分組方式，期能借助同儕的力量來協助學生學習。本研究之實驗設計如下：選定台北市某國小六年級 6 個班級，共計 148 名學生，並分成實驗組 3 班共 74 名學生；控制組 3 班共 74 名學生。實驗組接受同儕教學法；控制組接受傳統講述教學法。實驗組進行「異質分組」，依五年級資訊課程成績依序分成 A、B、C 等級，各取一等級學生組成一組進行教學。教學前填寫前測問卷，教學後將作品上傳至學生作品區並填寫後測問卷與自評、互評表。實驗教學進行 4 周（不含前測、後測），教學內容為影像處理軟體 PhotoImpact 的應用。

3.2. 研究工具

本研究所採用工具包含：(1) 同儕教學感知問卷量表：量表分為「小組長」與「一般組員」兩種版本。「小組長」問卷依「學習態度」、「學習助益」、「教學指導」、「同儕關係」、「電腦繪圖態度」五種向度進行編製；「一般組員」問卷依「學習態度」、「學習助益」、「同儕關係」、「電腦繪圖態度」四種向度進行編製。計算兩份問卷的 Cronbach's α 係數分別為 0.840、0.872。(2) 電腦態度問卷量表：由賴阿福、王維正、史婷慧（2006）所編製，問卷將電腦態度分為「電腦喜愛」、「電腦信心」、「電腦使用」、「電腦價值」、「電腦實用性」、「電腦焦慮」等六個因素。六個因素的 α 係數均介於 0.728 到 0.898，以全部題目進行信度考驗，所得係數為 0.912。(3) PhotoImpact 作品之評分：評分分為「基本技巧」、「進階技巧」、「美感」三部份，每項的滿分為 10 分，0.5 分為一單位，三項評分經由非任課老師進行評分與學生進行自評與互評，藉此探討不同教學法對學習成就之影響。

4. 研究結果與討論

4.1. 不同教學法對學生的 Photoimpact 學習成就之影響

本節探討不同教學法對學生的學習成就是否有差異，首先以學生作品進行評分，成績為三位評審教師分數的平均數。三項成績之平均數實驗組均高於控制組，需判斷兩組的三項成績是否為顯著差異因此進行獨立樣本 t 檢定分析，藉此探討不同教學法對電腦領域學習成就是否有影響。Levene 檢定值中的三組 p 值皆大於 .05，均未達顯著差異，故二組的變異數可視為

相等。進行獨立樣本 t 檢定分析結果，「基本技巧」與「進階技巧」兩項成績達到顯著差異（ $p=0.005$ 與 $0.011 < 0.05$ ），「美感」成績未達顯著差異（ $p=0.315 > 0.05$ ）。依據分析結果「基本技巧」與「進階技巧」方面，實驗組分數均高於控制組且達顯著，但在「美感」方面則不顯著，其因在於美感需經過長期培養，而非短期可以提昇。

4.2. 不同教學法對學生的電腦態度之影響

本節探討不同教學法對學生的電腦態度之影響，控制組後測分數低於前測分數0.552；實驗組後測分數高於前測分數4.1972。判斷差異是否為顯著，將控制組前、後測與實驗組前、後測分別進行成對樣本 t 檢定，分析顯示控制組電腦態度前、後測顯著性為0.831（ > 0.05 ）；實驗組電腦態度前、後測顯著性 p 值=0.108（ > 0.05 ），因此控制組及實驗組分別進行完教學活動後，電腦態度與教學活動前並無顯著差異。

探討這兩種學習方式，在最後的學習結果上是否有顯著差異？採用「共變數分析」，以「前測分數」為共變數；「組別」為自變數；「後測成績」為依變數。首先求得控制組與實驗組後測成績之迴歸係數同質性考驗分析摘要表。組內迴歸係數同質性考驗結果（組別*前測），其中 F 值=3.607， $p=0.060(>0.05)$ ，所以我們必須接受虛無假設，亦即符合共變數迴歸係數同質性假設，可繼續進行共變數分析。共變數分析結果，排除了前測成績的影響之後，實驗處理所得到的 p 值=0.022（ < 0.05 ），達顯著差異，表示實驗組進行同儕教學法之後，電腦態度顯著優於控制組。

4.3. 學生對於同儕教學法之感知與態度

本節探討學生對於同儕教學法之感知與態度，將同儕教學之感知問卷（小組長、一般組員）資料進行敘述統計分析，接著將兩版本之平均數分別除以題數，得小組長單題平均得分為4.236（分數最高為5分）；一般組員單題平均得分為4.129（分數最高為5分）。顯示進行同儕教學法後，小組長及一般組員對同儕教學法之感知與態度皆呈現高度正向表現。

依照問卷中的向度進行分析，結果在「學習助益」方面，小組長與一般組員的單題得分均為最高，可知學生也能清楚感受到同儕教學法對於學習上的幫助。在「學習態度」方面，小組長的分數也相當高，且標準差為所有向度中最小，可知學生擔任小組長後，上課的學習態度普遍較優；而一般組員則無此情形。

4.4. 不同教學法對作品自、互評成績之差異

本節探討不同教學法對作品自評、互評成績之影響差異，兩組之互評成績皆高於自評成績，接著進行成對樣本 t 檢定，進行自評、互評之差異性分析，控制組成對樣本 t 檢定結果 $p=0.309 > 0.05$ ，顯示控制組自評、互評無顯著差異；實驗組成對樣本 t 檢定結果 $p=0.028 < 0.05$ ，顯示實驗組自評、互評有顯著差異，且互評分數大於自評分數，搭配同儕教學之感知問卷中一題「對於經過同儕教學後提昇欣賞他人作品的能力」的分數達到4.5分（滿分5分），由此得知，進行同儕教學法後，學生對於欣賞他人的作品願意給予較高的評價，在互評建議方面，也更願意給予對方回饋，呈現較佳的欣賞風度與修養。

5. 結論與建議

5.1 結論

目前國小教師在進行資訊課程時，採用傳統教學法易導致學生在學習上有困難時無法獲得即時的協助與解答；且教師需針對全班每位同學產生的不同問題進行個別指導，易使課程進度延誤。因此本研究採用「同儕教學法」期能有效提升學生學習成效。研究結果顯示，控制組與實驗組學習成就方面，除「美感」沒有顯著差異性，「基本技巧」、「進階技巧」皆呈現顯

著差異，顯示「同儕教學法」相對於傳統教學法確更能增加學生之學習成效。在電腦態度方面，控制組與實驗組之電腦態度前、後測均無呈現顯著差異；但在共變數分析中，實驗組後測成績與控制組後測成績有顯著差異，顯示實驗組在電腦態度進步方面仍顯著優於控制組。同儕感知態度方面，實驗組進行同儕教學法之後，對於同儕感知呈現高度正向態度表現，因此同儕教學法確實能有效增進同儕感知表現。自、互評分數比較方面，控制組自、互評分數不具顯著差異；實驗組之自、互評分數呈現顯著差異，顯示接受同儕教學法之學生能給予他人較佳之評價，也與同儕感知問卷中肯定自己提昇欣賞他人作品能力之結論相吻合。

5.2 建議

根據本研究的結論，「同儕教學法」確實能有效提昇學生的學習成效與同儕感知態度，但在此教學模式中，教師需隨時掌握各組的學習狀況，避免因個人因素影響整組學習效果。若需進行以小組為單位的學習作品製作，亦須注意每位學生的參與程度，避免有學生參與度或貢獻度偏低的情況發生。

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科技學科教學知識觀點下之線上輔導教師教學模式初探——以英語線上輔導教師 為例

An Initial Probe into the E-Mentors' Teaching Pattern through the perspective of TPACK: A Case in EFL E-Mentors

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【摘要】教師如何在感知、運用與融合多項新興科技資源下，發展適切、彈性之教學模式，實為今日師資培育中所強調之能力。本研究透過質性為主，量化資料為輔之研究取向，採不斷比較分析法進行資料萃取，探究英語線上輔導教師之教學歷程。研究除發現教學資源運用、教學歷程轉移與教學情感移植三類相互融合使用之教學模式外，並以科技學科教學知識之觀點，提出線上輔導教師之渦輪教學模式。

【關鍵詞】科技學科教學知識、線上輔導教師、教學模式

***Abstract:** It is indeed an emphasized ability of teacher education of a flexibility of an appropriate development of teaching pattern based on teachers' perception, application, and integration of a number of emerging scientific and technological resources today. The research orientation of this study was mainly through qualitative method with quantitative data supplemented, and there was a constant comparison analysis method adopted for data extraction to explore the teaching of English language course online tutors. The study found out one teaching pattern of the mutual integration of teaching resources application, teaching process transplantation, and teaching affection transplantation. Furthermore, this study put forward turbine teaching pattern followed by scientific and technological pedagogical content knowledge.*

Keywords: Technology Pedagogical Content Knowledge, E-Mentor, Teaching Pattern

1.研究背景與目的

在全球化的趨勢下，富有者更容易於數位世界中，中產階級則會失去競爭力，淪為中下階層，亦即 M 型化社會的概念。故在強調資訊科技需融入課程教學的浪潮中，教師們如何感知新興科技、如何在挪用與融合多項資源，發展出適當的教學模式，乃成為值得深探之議題。

本研究目的如下：一、瞭解英語線上輔導教師之網路學科教學知識。二、探析英語線上輔導教師教學模式。三、以科技學科教學知識整合分析線上輔導教師於網路課程平台之教學模式。

2.文獻探討

2.1.線上同步教學模式

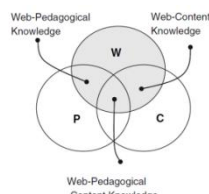
同步學習是指所有參與學習的人員必須在同一時間透過傳輸系統產生互動。不只突破了上課地點的限制，對於協同作業環境的支援，如同步分享即時輔助工具等，亦有很大的進步。

2.2.科技學科教學知識的發展歷程與內涵

科技學科教學知識指教師對某學科特定主題及配合學生學習能力與興趣的條件下，用對學生們最有效吸收方式傳達知識給學生。為一種建立在教學工具知識和功能的知識體系，將教學、內容、學習者和背景相互整合，並採用適當科技工具以達成有效教學。

2.3.網路學科教學知識的發展歷程與內涵

承襲 Mishra 與 Koehler(2006)所提出的科技學科教學知識理念架構下，Lee 與 Tsai(2008)結合網路知識、網路內容知識與網路教學知識提出網路教學學科知識概念，如圖一。本研究線上輔導教師均藉由網路進行線上同步教學，故採 Lee & Tsai(2008)之網路學科教學知識問卷作為量化研究工具，蒐集線上輔導教師於網路學科教學知識之信心程度，並進行後續研究。



圖一：網路學科教學知識(TPCK-W)架構圖

3.研究設計與實施

3.1.研究方法與對象

本研究主要採蒐集、組織及分析資料，以不斷比較分析法進行個案資料概念萃取，並以多重檢證法進行驗證及引導資料分析策略。且排除於教學歷程中退出、無法配合教學等多項干擾變項影響，最終選出完整參與教學且各項實務經驗的兩位教師進行深入探究分析。

3.2.研究工具及資料蒐集

質性資料蒐集包括師生課堂對話錄音檔、課堂觀察筆記及對選定個案之教師進行半結構式訪談，進行多重驗證。量化資料採 Lee & Tsai (2008)網路學科教學知識問卷分析教師網路學科教學知識信心程度，共三十題，為李克特式六點量表。分成一般網路知識、網路溝通、網路學科內容、網路學科教學與態度項度，其信度為.94、.96、.94、.95 及.92，整體量表信度為.96。

4.資料分析與結果

4.1.英語線上輔導教師背景及相關資訊

本研究所選之兩位研究個案其背景為：02 號女性(02F)與 13 號男性(13M)教師，是否就讀英語相關科系、擁有英語相關證照及實體面對面教學經驗三項中，02F 均符合，13M 則反之。

4.2.英語線上輔導教師之網路學科教學知識之能力

結果顯示，18 名線上輔導教師於五個構面之單題平均得分為：5.58、4.79、5.27、4.84、5.06，並以前後 27%為基準，分成高、中、低三組，作為後續檢測、對比映證分析之資料。

4.3.英語線上輔導教師之教學模式

從師生雙方進行線上教學錄音檔資料及蒐集的相關質化資料中，包含了教學資源運用、教學歷程移轉與教學情感移植三大項，其結果和發現分述如下：

4.3.1. 教學資源運用部份

4.3.1.1. 教材使用

英語線上輔導教師(02F)教材使用部份以平台課程內容和教師自編為主；教師(15M)則採平台課程內容和其他教材為主，包括使用網路學習資源、英語學習相關教材等。

4.3.1.2. 平台資源

教師(02F)於教學中廣泛的使用到所有平台資源；教師(15M)主要使用課程動畫和闖關活動等功能。因教師(02F)為參與設計英語學習平台課程的教師，故較熟悉平台功能及其資源。

4.3.1.3. Skype 資源

在教師(02F)教學中以文字訊息對話和檔案傳輸為主；教師(15M)則多採文字訊息對話部份進行輔導教學。另外，此兩位線上輔導教師均無使用到桌面分享之新功能。

4.3.1.4. 額外資源

教師(02F)在額外資源部份以視訊設備結合手繪字卡、書本圖卡之運用為主，而教師(15M)則偏向多以網路資源如線上字典的使用和線上學習資源作為教學輔導中使用之工具。

4.3.2. 教學歷程移轉部分

4.3.2.1. 學習經驗

教師(02F)多採諧音聯想記憶規則；教師(15M)則分享學習經驗，將新單字抄於筆記本隨時記憶。兩位教師均依其學習經驗，進行複製並傳授教導給學生，實與師徒制理念相當契合。

4.3.2.2. 科技技能

於教學歷程中發現教師擁有的科技技能會移轉至學生身上，即學生會習得科技相關技能。教師(02F)於平台、Skype 介面操作與其它技能均有相當程度涉入；教師(15M)於平台、Skype 介面操作文字對話訊息使用較多。教師(02F)於科技技能轉移部份呈現出較為頻繁狀態。

4.3.3. 教學情感移植部分

4.3.3.1. 環境營造

兩位教師均具備關懷問候、風趣互動與正向鼓勵，但教師(02F)鼓勵部份明顯多於缺乏實體教學經驗教師(15M)，顯示教師(02F)在長期實體教學經驗下，易於營造線上學習環境氛圍。

4.3.3.2. 責任歸屬

兩位教師在教學歷程中自發性提供電子郵件或手機號碼，讓學生遇到學習上的問題時，能有問題解決的管道。而教師(15M)則於教學歷程中不斷向學生說明英語在未來的重要性，期待學生能藉此機會好好用心把英語學好之動之以情，訴之以理的狀況出現。

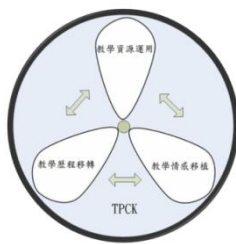
綜合歸納教學資源運用、教學歷程轉移與教學情感移植三大類別組成的英語線上輔導教師之教學模式中，在單一類別下必會與其他兩個類別有所結合移轉，其模式圖如圖二所示。



圖二：英語線上輔導教師教學模式圖

4.4. 於科技學科教學知識下英語線上輔導教師於網路課程平台之教學模式歸納

分析歸納之英語線上輔導教師教學模式，與 Mishra & Koehler(2006)強調間的科技學科教學知識觀點結合概念下，研究者進一步將兩者相互融合，並提出渦輪教學模式，如圖三所示。



圖三：英語線上輔導教師於網路課程平台之渦輪教學模式圖

5. 結論與建議

5.1. 結論

5.1.1. 渦輪教學模式提供線上輔導教師明確清晰之教學模式、教師角色與定位

輔導教師扮演提供和結合教學資源運用、教學歷程移轉及教學情感移植之角色，三類別移轉結合的教學模式以扇葉圖示呈現，於科技學科教學知識框架下，自由彈性的轉動和運作。

5.1.2. 教師需具備科技學科教學知識，並以多元、彈性、創意方式運用在教學中

如圖三，線上輔導教師之角色串連三項度之軸心部份，扮演著啟動渦輪教學模式之要務，於科技學科教學知識的框架中，啟動教學模式的扇葉，使得渦輪教學模式得以順利運作。

5.1.3. 教學情感移植仍為科技學科教學中不可或缺之元素

本研究發現教學情感移植實為渦輪教學模式中不可或缺要素，與 Bloom(1956)提出認知、技能、情意三大教學目標相互呼應，教師除有效運用教學資源、運用學習遷移原理讓學生學會相關技能外，尚需在教學過程有情感性的互動與交流，協助學生達到情意教學的目標。

5.2. 建議

5.2.1. 建立提升線上輔導教師相關科技知識培育與教育訓練之管道

藉定期的教師經驗分享、新興科技媒體使用與說明、教材製作技巧及提供教學觀摩與演練，同時並規劃出一套教育訓練之流程模式，讓線上輔導教師能藉此管道，不斷更新知識。

5.2.2. 整合跨學科的資訊並參與相關輔助教材之開發

教師需能整合、製作與運用網路資訊，並建立起學科網路教材編撰和開發團隊，研擬出更適切之教學教材，藉此帶給學習者更多方位的學習。

5.2.3. 結合政府行政部門或非營利團體之推廣與運用

與相關科技業者協商並提供更具多樣化的學習資源，進一步爭取政府政策和補助，藉由非營利組織團體的力量，充分的將此英語學習模式成功的推廣至每一個需要幫助學習者。

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數位敘事技術應用於總結主題探索課程對教師專業成長之影響

The Impacts of Digital Storytelling about Project-based Learning Courses on Teachers Professional Development

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【摘要】本研究之目的，係在探討運用數位教學個案陳述之方法，以增進教師運用主題探索課程之專業知能的可行性。本研究之假設有二：(1) 教師在製作數位教學個案時，可以重新自我檢視教學的歷程與成果，因此可以產生專業反思的效果；(2) 教師透過電腦網路進行數位教學個案陳述的分享與瀏覽，可以產生教學觀摩的效果，並進而促進教師之專業成長。為驗證前述的二項假設，本研究進行實證研究，並訪談五位參與研究歷程的資深教師後，他們皆表同意本研究的二項假設，因此本研究肯定數位教學個案陳述在強化教師運用主題探索課程上之專業發展功能。

【關鍵詞】主題探索課程、數位教學個案陳述、教師社群、教師專業成長

Abstract: The goal of the study is to investigate the feasibility of strategy in teachers professional development with digital storytelling about project-based learning courses. There are two hypotheses in the study: (1) Self-reviewing and rewinding of the processes and outcomes of the instruction while teachers are creating digital storytelling probably could result in professional reflection. (2) The sharing of digital storytelling video about instruction among peers through Internet might have the same effect as personal observation of the classroom instruction. It may also promote and facilitate the development and practice of teachers community with peer evaluation and coaching on the products of digital storytelling about instruction. These might imply that community of practice among teachers on digital storytelling about instruction could fertilize teachers professional development. With an empirical experience, the study concludes that digital storytelling about instruction in the practices of project-based learning has positive impacts on teachers professional development.

Keywords: Project-Based Learning, Digital Storytelling about Instruction, Teachers Community, Teachers Professional Development

1. 研究目的與問題

本研究將主題探索課程作為教師應用教學方法的核心，並透過教師在製作數位教學個案陳述的過程中加以反覆思考自我之教學經驗，與分享教師所製作的數位教學個案陳述能夠在網路教師學習社群中來和其他同儕教師相互鼓勵、討論、切磋，以期能夠就藉由此方式提昇教師本身之專業成長。

因此，本研究所指的教師專業成長，是教師自行設計並實施主題探索課程，再藉由製作數位教學個案陳述的過程中所產生的教學專業反思，與運用資訊科技能力的提昇，及與其他同儕教師對於所分享的數位教學個案陳述進行教學觀摩延伸出來之專業對話，透過同儕輔導與製作教學個案陳述時的反思來達成自我之專業成長。

基於上述之研究目的，本研究擬定下列三項研究問題與方向：

(1) 教師製作數位教學個案陳述過程中，是否能夠產生專業反思？

研究者將嘗試實證透過數位教學個案陳述的應用，讓教學者在製作的過程中，重新反思自我之教學過程，及學生之學習反應狀況，提供教學者在下一次進行教學時可以去修改自我的教學方法。

(2) 教師分享數位教學個案陳述進行教學觀摩與同儕輔導，是否能提昇自我專業成長？

研究者將嘗試藉由教師將製作完成的數位教學個案陳述在網路教師社群中分享，讓更多教學者可以去進行教學觀摩與相互評量彼此之教學方法並討論，提昇教師本身之專業成長，提高教學者教學自信心。

2. 研究方法

本研究擬以讓教師拍攝以主題探索課程內容為基底的教師教學過程函括學生學習狀況，並融合學習成果展現，應用多媒體科技技術重新整理編輯數位教學個案陳述，並鼓勵每位教學者加以分享其成果，透過網路進行教學觀摩與促進在製作過程時的教學反思，來達到個人與他人之專業知能成長。

為進行實證研究，本研究考國內外線上學習社群之特色，注意其人際互動、系統介面設計，規劃使用者與社群的經營方式、及設計數位教學個案陳述呈現的方式，進而規劃與完成了一個專業網路教師學習社群網站：群學網 (<http://cop.linc.hinet.net/>)。

2.1. 教師研習

在實證研究階段，由於群學網為一個全新的專業網路學習社群網站，所以需要先建立主題探索課程內容，鼓勵相關任課教師對其所設計之課程進行教學活動。因此本研究與高雄市數學領域領航教師及南區跨縣市數學輔導員所辦理之「資訊融入數學教學工作坊」相互合作，引導教師學習如何設計主題探索課程與應用資訊科技製作數位教學個案陳述。

2.2. 教學實施

研習完成之後，輔導教師依其所設計的主題探索課程進行教學活動，並在授課過程中請教師隨時以數位相機或是攝影機紀錄學習者參與課堂學習情況，再將學生活動情形照片或影片重新歸納整理，應用資訊技術編輯成數位教學個案陳述，其內涵將著重教師教學過程、學生參與狀況、學生學習成果展現、學生學習反應與教師自我教學省思。再透過群學網提供之上傳機制在上傳數位教學個案陳述後，可再以文字補充相關任教班級情形和教師任教後之反思回饋，並於開課教師主動分享後。得以讓其他教師透過分享機制更了解上課學生課堂狀況，並思考自己任教班級是否適用此教學方式，而其他社群成員則可以提供相關反思回饋給開課教師。

2.3. 訪談

本研究採用訪問調查研究法，我們參考參與活動的教師之教學背景，包含任教身分、任

教科別、任教年資來進行訪談，期望可以藉由訪談來深度瞭解教師，對於使用數位教學個案陳述進行教學觀摩與專業反思提升專業成長的真實感受。

3. 研究結果與討論

本研究訪談了五位教師，其中有4位國小教師1位國中教師。當訪談的逐字稿整理完成後，研究者對逐字稿進行分析及編碼研究，並採用內容分析法進行分析，以評估是否可以驗證本研究之研究假設是否能成立。

3.1. 教師製作數位教學個案陳述過程中的專業反思

本研究假設，透過數位教學個案陳述的應用，讓教師可以從短片的規劃、編排、佈署、製作到完成的過程中，得以重新反思自我之教學過程、學生之學習反應狀況、及所遭遇種種的問題等，而透過這種教學後的反思歷程，可提昇教師本身之專業成長、教學自信心，並且更加認識自己。

本研究經分析與歸納訪談紀錄後，發現教師對於製作數位教學個案陳述皆可持正向態度來面對，雖在製作的過程中會碰到許多問題，像是教學過程時的拍攝問題、學生學習過程與成果的展現、親師之間的溝通、資訊技術能力的不足...等，但教師們仍願意突破萬難來完成。且每位受訪者皆表示，藉由在製作數位教學個案的過程中所帶來教學上的反省、刺激與改進，都可達到個人本身之專業反思，提供自己在教學生涯中的另一種動力。

3.2. 教師分享數位教學個案陳述進行教學觀摩與同儕輔導

本研究假設，藉由數位教學個案陳述的分享，讓更多教學者可以不受時空的限制隨時進行線上教學觀摩，並可與其他教師同儕間相互討論彼此之教學方法、班級經營方式及親師互動...等，並藉由他們的想法與經驗的分享，引導其他教師也可以學習並改善自我之教學方法。

本研究發現，教師對於一般傳統的教學觀摩較不感興趣，可能是因為觀看傳統教學觀摩需要特別安排特定觀摩班級與花費較多時間，且在當下不容易掌握出教學與課程重點所在，但若可以應用數位教學個案陳述進行教學觀摩，不但可以隨時透過網路進行教學觀摩，更因為教學個案陳述的內容是在授課教師重新規劃整理之後的產出，使之變得更加精簡且明白點出教學重點所在，讓其他教師在觀看的時候，可以獲得事半功倍的專業成長。

且大多教師也提到在觀看他人數位教學個案陳述的過程中，遇到好的作品可以突破自我觀念與教學迷思，從中學習到更多元的教學方法，反思自我教學內容並重新轉化運用；但若遇到較差的作品，則可以經由同儕輔導的方式相互討論修改教學方法或是呈現方式，相互勉勵教師要突破困難積極學習。及鼓勵教師要有開闊的胸襟與專業自信心，勇於分享自己的數位教學個案陳述，並大方接受各方的讚美或是誠懇接受別人的指教，相互砥礪茁壯成長。

4. 結論

4.1. 教師在製作數位教學個案陳述過程中可以進行專業反思及提昇

自我運用資訊科技的能力

教師在透過製作數位教學個案陳述的過程中的確可以進行專業反思，並由反思來獲得個人本身之專業成長，得以改善自我之教學方法、學習他人之教學優點、活化自己教學現場的

反應能力。並且藉由製作數位教學個案陳述可以作為自己教學歷程的一種紀錄，讓自己可以更加有系統、有目標的蒐集自我教學經驗，也可以增加讓教師不斷督促自我往前學習的動機。且經由製作數位教學個案陳述證實可以提昇教師使用資訊科技的能力，並讓教師不在那麼害怕應用多媒體科技產品。

4.2. 教師藉由數位教學個案陳述進行教學觀摩可以改善教學方法與掌握教學目標

傳統的教學觀摩大多費時且費精神，但藉由數位教學個案陳述可以讓教師更有效率的進行教學觀摩，是因為它已將教學觀摩的過程濃縮且重新經過省思加以編輯而成，讓觀賞的教師可以僅僅花 3-5 分鐘便看出整場教學過程的精華所在，也讓教師可以更容易掌握整個主題探索課程的教學目標與可應用的教學方式，也藉由觀看他人的教學方法進一步改善自我的教學方法。且因為數位教學個案陳述是透過網際網路進行播放，因此更可以讓教師利用自己有效的時間內進行專業成長。

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Exploring Factors Affecting Farmers' Perception of Learning Information and Communication Technologies

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Abstract: *This study intends to explore factors that affect farmers' perception of learning information and communication technologies (ICTs). It further analyzes effects of individual characteristics and different attributes of training design on farmers' perception of learning ICTs. The study uses data from the Farmers' ICT Training Project of 2005 conducted by Council of Agriculture, including evaluations of 4,332 trainees, of which 2,096 from introductory ICT training program and 2,236 from advanced ICT training program respectively. Results of this study reveal that farmers' characteristics and attributes of training design do have effects on learners' perception of effectiveness. Through factor analysis, it also finds different sets of factors pertaining to such two types of ICT training programs. There are training course and instruction, training planning, and training administration factors contributing to farmers' learning perception of the introductory ICT training; and training planning and development, and training administration factors contributing to farmers' perception of the advanced ICT training program. This study further analyzes and discusses impacts of farmers' characteristics on their perception of learning in different types of ICT training programs.*

Keywords: learners' perception, information and communication technology (ICT) training, perception of effectiveness, factor analysis, hierarchical linear model (HLM)

1. Introduction

To understand what factors contribute to learner's perception of learning effectiveness can help program planners to develop an effective, useful and helpful training program. This paper describes the relationship among the demographic characteristics of learners, organizational characteristics, and farmers' perception of learning ICTs. The focus of this study is the ICT Training of farmers in Taiwan, and employs data from Farmers' ICT Training Database, built upon a national farmers' ICT training survey.

In technology related training research studies, the influence of individual difference has always been a popular topic. Bartel & Lichtenberg (1987) reveal that highly educated workers have a comparative advantage with respect to

their adjustment to and implementation of new technologies. Since the specific experience with the technology is considered important for adoption and implementation, educated farmers can more easily learn to use a microcomputer and its accompanying software (Huffman & Mercier, 1991). Mathieu, Tannenbaum, and Salas (1992) indicate the influence of education on learning was positive based on a model taking into consideration the individual and situational influences on learning motivation and learning effectiveness. Morris (1994) also confirms attributes of participants result in a positive influence on learning in a computer course. Lee (1997) reports that computer or programming experts may have great technical skills but are not aware of certain aspects of adult learning characteristics. Once the training fails to help adults learn, the training ceases to be effective. To adults who attend such types of ICT training, thus, they remain anxious or unskillful in using ICTs.

Prior studies also reveal a focus on individual difference variables that are associated with learning about end-user software. In summary, most of the studies have focused on individual differences, and personal traits such as age, educational background, and experiences with specific software, overall computer experiences, gender and years of education (Bostrom, Olfman, & Sein, 1990). Therefore, individual differences among potential trainees should be taken into account when developing a training program (Chou, 2001; Liu & Reed, 1994). In this study, variables of age, gender, educational background, occupation, ICT experience of learners are explored. Few previous studies, however, relate organizational characteristics to individual learning outcome. This paper also attempts to address such deficit. This study utilizes a hierarchical linear model (HLM) to address questions about the empirical relationships among learner characteristics, organizational characteristics, and perceived learning effectiveness.

HLM is an analysis method frequently used in many research fields, such as education (Clapp, et al., 2007), social policy (Jasuja, et al., 2005), public health (Woodward, Das, Raskin, & Morgan-Lopez, 2006), and training evaluation (Feinberg, Greenberg, Osgood, Anderson, & Babinski, 2002). Considering both individual and organizational effects on learner perception of learning effectiveness, this analysis takes into account both individual and organizational factors in relation to learner perception about ICT training.

2. Methods

2.1. Farmers' ICT Training Database

The Farmers' ICT Training Database is developed with the support of the Council of Agriculture, Taiwan (COAT). It is hoped this training program can enhance ICT literacy of farmers and related agricultural workers. In the Farmers' ICT Training Database, information about learners' demographic characteristics and background data like years of farming, types of crop planted, and farm size, etc. is collected. At the end of each ICT training program, learners are required to complete a post-training questionnaire also included in this database. This questionnaire collects learner perception of training satisfaction, usefulness of training materials, mastery level of ICT use, and confidence of applying what they have learned in the training.

2.2 Sample and Research Question

The study population includes 2,671 learners who complete Farmers' ICT Training provided by the COAT. Among them, 1,291 trainees are the participants of basic class and 1,380 trainees from the advanced class. In addition to personal characteristics, this study also uses data of organizational characteristics and learner perception of effectiveness in response to the research questions. The research questions of this study include:

1. Is there any relationship between farmers' individual characteristics and perception of learning ICTs?
2. Is there any relationship between training providers' organizational characteristics and farmers' perception of learning ICTs?

3. Do organizational characteristics moderate the relationship between farmers' individual characteristics and perception of learning ICTs?

2.3 Research Variable

The variables included in HLM analysis of the present study originate from two separate datasets. One consists of individual demographic data of 5,133 trainees enrolling in COAT's ICT training program. The other covers data related to learner perception of learning ICTs of farmers, including perceived training satisfaction, usefulness of training materials, mastery level of ICT use, and confidence of learning transfer. For analyses, learner perception data are utilized as the dependent variables in this case. In addition, five personal characteristics used as independent variables in the analysis include: gender, age, educational background, occupation, and ICT experience of farmers. Moreover, three organizational variables are used in this analysis. The first one concerns type of training (basic vs. advanced). The second organizational variable is training host. This variable is defined taking into consideration the administrative level of training providers as well as how training program is implemented. The third one is related to region of training delivery. Since the resource distribution and economic development in Taiwan is not equal, the regional development is also different to some degrees. The region of training delivery factor is taken into consideration in this study to explore if variance exists among different regions.

In addition, four dependent variables are employed to explore farmers' perception of learning ICTs in terms of learning effectiveness. The first is the perceived satisfaction, which is constructed to understand how learners feel satisfied with the ICT training held by COAT. The second criterion is perceived usefulness, which means the perceived usefulness of training. The perceived usefulness can help designers to understand the usefulness and appropriateness of such ICT training. The third criterion is perceived mastering of learning, which means the perceived learning of personal learning outcome, measuring the perceived ICT mastery level. The fourth criterion is the perceived confidence of learning transfer, which means the confidence of applying what they learned from the training program.

3. Results

This section is divided into three parts. First, the descriptive analysis of the sample is presented. The measurement of perceived learning effectiveness consists of four scales. In Basic class, the Cronbach's α values of these four scales range from 0.81 to 0.92. In Advanced class, the α values range from 0.75 to 0.94. Both results confirm the measurement of perceived learning effectiveness criteria has acceptable internal consistency.

3.1 The analysis sample

The participants in this study are 46 years old in average, 71.3% are female, 54.6% with a senior high school education and common ICT experience. In addition, 58.4% are non-farmer participants. Considering the influence of the training design, 1,291 learners participated in the basic program and 1,380 participated in the advanced program. Females, whose age from 40-49 years old with high school education are the major participants in both two programs. The participants in both program had experience with ICT, but participants who attended advanced program are more familiar with ICT. Participants have positive perceptions of learning new technology.

3.2 Learner-level and Organization -level predictors

The results of learner-level predictors showed that all characteristics of learners have influences on farmers' perception of ICT learning effectiveness. The gender and educational level had influences on perceived usefulness, perceived mastering of learning and perceived confidence of learning transfer. In these criteria, the perception scores of male are higher than the female. The learners with higher level of education also have more positive perception in these criteria. The occupation only has influence on perceived usefulness. The non-farmer learners have more positive

perception of training usefulness. Also, elders tend to have more positive perceptions on all four criteria of perception of ICT learning effectiveness. The ICT experience of the learners also influences the perceived satisfaction, perceived mastering of learning and perceived confidence of learning transfer. The learners with more ICT experience are more familiar with ICT, and tend to have more positive perceptions. In the organization-level predictors, the results of HLM analysis showed that level of training had influence on perceived satisfaction and perceived usefulness. The learners in basic classes had more positive perception of satisfaction and usefulness. The characteristics of types of training host and regions of training delivery do not result in significant influence on all criteria of farmers' perceptions.

3.3 Interactions between Learner- and Organization-level predictors

This analysis uses slopes-as-outcomes model to explore interactions between learner- and Organizational-level predictors. This model also tests the moderating effect of organizational variables. Results of analysis show regions of training delivery moderate the relationship of gender and age as for the perceived satisfaction. Also, regions of training delivery moderate the relationship between age of learners and their perceived confidence of learning transfer.

4. Conclusions and implications for future research

These findings about learner characteristics and farmers' perception of ICT learning effectiveness are consistent with what has been found in the literature, generally. The key factors like the gender, age and educational background of learners are supported in this analysis. The HLM analysis confirms not only learner-level predictors, but also organization- level predictors have effects on learner perception of effectiveness. The age of farmer learners has influence on all criteria, consistent with prior study results (Gist, 1988; Lee, 1997; Mayhorn, Stronge, McLaughlin, & Rogers, 2004). The educational background has the influence on perceived usefulness, perceived mastering of learning and perceived confidence of learning transfer, also consistent with literature findings in the computer and Internet research (Chou, 2001; Davis & Davis, 1990; Whitley, 1997). Similar to other computer and Internet training programs, male learners perform better than female learners, and learners with higher education level perform better than the others. The occupation only influences the perceived usefulness. The ICT experience of the learners has influence on perceived satisfaction, perceived mastering of learning and perceived confidence of learning transfer.

In the organization-level predictors, results reveal types of training have influence on the perceived satisfaction and usefulness similarly evidenced in literature (Lim & Morris, 2006). This different design of training leads to the decrease in the perceived usefulness in advanced class. Type of training host and region of training delivery do not have influences, and this is possibly due to the universal training materials and implementation of pre-training for related trainers. Other organizational factors of training host and regions may also decrease its influence effects. Moderating influence exists between the learner- and organization-level predictors. The results reveal the perceived satisfaction and confidence of learning transfer are moderated. The relationship between ICT experience and perceived satisfaction is moderated by the region of training delivery, and the relationship between age and perceived confidence of learning transfer is also moderated by different regions of training delivery. The most important contribution of this analysis, however, is that it offers findings on the link between the perceived learning effectiveness and organizational structure as well as learner profile, which has not been systematically studied yet because of the lack of a large database for such analyses. The availability of Farmers' ICT Training Database makes this possible.

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Fostering Teacher Agency for Scaling up an iMVT Innovative Pedagogy for Science Learning

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Abstract: *In this study, we report how we have prepared teachers to adopt, sustain, and scale up an innovative pedagogy as part of an education reform effort. We examined teacher agency using agency/structure lens when promoting an iMVT (Modeling and Visualization Technology integrated inquiry-based science learning) pedagogy. Furthermore, we went beyond short workshops to form a community of teachers through an online forum. This allows “mentor teachers” and researchers to support newly joined teachers over the course of their designing and enacting technology integrated curriculum materials. In this paper, we focus on a case of a physics mentor teacher to illustrate how existing and emerging structure/resources enabled and developed her agency in sustaining and scaling up the iMVT innovation.*

Keywords: Teacher agency, scale up, modeling and visualization, secondary science

1. Introduction

Over the past 14 years (since 1997), Singapore Ministry of Education (MOE) has issued three IT MasterPlans for schools to integrate the use of Information Computation Technology (ICT) into school teaching and learning. In the MasterPlan III (MP3), ICT was adopted to leverage reform efforts in fostering inquiry and student-centered learning (MOE, 2008). To fulfill the goals as defined in MP3, a group of researchers have developed and implemented over the past four years an iMVT (Modeling and Visualization Technology for inquiry-based science learning) innovative pedagogy (Zhang, Ye, Foong, & Chia, 2010) in primary and secondary schools in Singapore. A *Modeling* approach allows students to represent and construct understanding of science phenomena as complex systems by elaborating on variables, relationships, and the interaction among the components of the systems. *Visualization* is to simulate abstract and invisible interactions (e.g. particle level interaction during chemistry reactions) through visible manipulative. This usually involves the use of *Technology*. MVT integrated *inquiry* not only makes learning more student-centered but also enables students to understand the underlying structure of science phenomena. However, how to prepare teachers to adopt, sustain, and scale up technology integrated innovative pedagogies as an education reform effort remains a challenging issue. Although we cannot address all issues of sustaining and scaling of innovations such as co-designing of curricular and reaching out to school administration, we adopt a ‘train the trainer’ approach (Sayre & Wetterlund, 2002) and use a case study of a Physics senior mentor teacher Victoria (all names are pseudonyms) to illustrate how a teacher’s agency is instrumental in this process. Our collaboration with Victoria started in February 2007 from the MVT project for about 22 months (Zhang, Jacobson, and Kim, 2007). A follow-up project, MVT II, was granted in early 2009 with the involvement of four secondary schools in Singapore (Zhang, Foong, 2009).

The following two questions guided the research:

- a) What was the agency a teacher demonstrated when adopting and implementing an innovative pedagogy?
- b) How to develop a teacher’s agency through teacher-researcher collaboration?

2. Literature Review

In this section, we briefly review the literature on sustaining and scaling up educational innovations. Next, we look into what constitutes teacher agency as one of our strategies to sustain and scale our innovative pedagogy. Introducing innovation and methods involves a variety of issues and stages (Davis, 2003; Rogers & Olaguera, 2003) and the importance of involving teachers in curriculum innovation has long been recognized (MacDonald & Rudduck, 1971; McIntyre & Brown, 1979). Teachers tend to shape and infuse their own beliefs into the implemented curricula. They might operate their classrooms according to their own particular definitions of teaching and learning (Yero, 2002), therefore, teachers have their agency to make or break reform efforts. Vora & Barton, (2006) defined *agency* as individual or group effort to influence the surroundings in purposeful ways. The aim is to create, impact, and/or transform themselves and/or the conditions of their lives. Agency is usually coupled with structure in cultural sociology because agency is shaped by structure. *Structure* is a set of rules and resources that actors draw upon as they produce and reproduce societal norms in their activities. It includes virtual *schemas*, intangible values, beliefs, and ideas that affect actions (Sewell, 1992), and tangible *resources*, such as social class, religion, gender, ethnicity, technology infrastructure in schools. It can both enable and constrain how human agents influence the world around them (Giddens, 1976).

3. Methods

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The current research study is part of a larger project that followed a design research tradition using narratives to describe the iterative processes of an innovative pedagogy in the classroom (Bannan-Ritland, 2003; Brown, 1992; Dede, 2005). Using the *agency/structure* lens (Sewell, 1992), we examine the development and interaction of teacher agency with existing structures (schemas and resources) in iMVT adoption for the case of teacher Victoria. The case study method is aligned with the three conditions defined by (Yin, 2009) with regards to type of research questions, investigator control, and focus of event. We would discuss in terms of context and timeline, the teacher profile, data sources and analysis respectively in the following paragraphs.

Although all three Sciences are involved in this project, we focus on the Physics subject group for this study. For the MVT II project, nine Physics teachers from three different schools with different student profiles and geographical zones in Singapore have agreed to adopt iMVT pedagogy for their teaching. The number of physics teachers has scaled up from three in the MVT project to nine in the MVTII project. Victoria is a former MVT teacher who wanted to continue working with the research team as the mentor teacher from Mendel school. The school is the lead ICT schools in their school zone cluster. Professional Development of teachers and curriculum design of the iMVT pedagogy was carried out from August 2009 and ongoing. The enactment of the co-designed curricula will start in mid-2010.

Victoria has eighteen years of teaching experience of the Physics subject. She has a local Bachelor degree and an overseas Masters degree. She has previously worked in three other secondary schools before and settled at this school, Medel, as a senior teacher in her seventh year. After going through the previous MVT project, Victoria was invited to be the Mentor teacher to lead the other eight Physics teachers in this follow-up MVTII.

Data presented in this study is based on transcripts of two semi-structured interviews with teacher that lasted slightly over an hour each as well as researchers' observation field notes of teachers' Physics subject group discussion. The two interviews were conducted separately before MVT project to find out teacher's initial beliefs about teaching and the research project, and before MVTII to allow teacher to reflect the past journey and explore her objectives for the follow-up project. Audio and video recordings of two Physics subject group discussions led by the mentor teacher were also collected and transcribed. These data were used to triangulate researchers' observation field notes as well as short briefings whenever possible with the teacher in phone calls and emails to understand more from the teacher. The preliminary data analysis follows the *agency/structure* framework presented in the literature review section. Below we present the existing and developed structures by researchers in terms of *schemas*, *resources*, and the teacher *agency* by Victoria.

4. Results

4.1 Teacher agency demonstrated

We present the agency Victoria displayed in the following paragraphs in persuading her school administrators to participate in MVT and MVT II and her willingness to take risks in education innovations. Despite the constraints such as limited preparation and meeting time, uncertain student learning outcomes, and working with teachers who teach students with varied profiles, Victoria took the risk to join the MVT project. As examination results are high stakes for students in the Singapore school system, Victoria had to consider the different demands and put in tremendous efforts to accommodate the needs of researchers and her Science Head of Department (HOD), as well as ensuring her students benefited in their learning. She stated that she took a "60% to 70% risk" three years back after a self-reflecting process in the interview for MVTII, demonstrating her agency to join the project. She revealed the risk she had taken: "use my head la, to guarantee that the results will not falter".

Victoria's beliefs of the iMVT pedagogy and rapport built with the researchers also prompted her to share this with more teachers and convince school leaders to allow her school to participate in the follow-up project. She managed to persuade her Science HOD in school and her Principal that student results and her experience in MVT was successful enough to stay on the MVT II project. She was committed to also help other physics teachers on the MVT II project by taking the leadership on teacher learning and curriculum development.

4.2 Existing structures and enabled structures to foster the teacher's agency

Agency can be constrained by structure. Therefore, we explored existing structure and tried to build new structure to enable teachers like Victoria to demonstrate their agency. First we look at the schemas part of structure: Victoria's beliefs in student learning and iMVT. In the excerpt below, she showed her transformation towards student-centered pedagogy:

It's very... I think it's like a metamorphosis...from the Day 1 that I started teaching until now. Day 1 when I started teaching I think my philosophy was erm... just to teach. Like whatever the book say, k, I'm just the agent for the book..... Er, after 16 years, I think I'm now more differentiated. More ability driven. Er... more... I would say more in tuned with learner styles. And I think, I appreciate more of like diversities on me. [Victoria Pre-interview January 2008]

Here she talked about her change in mindsets towards teaching over the years and this marks a good starting point for her agency to adopt the iMVT pedagogy to teach Physics.

In Victoria's conceptualization of iMVT in teaching, she believed that "ICT is a visualization tool" that both teachers and students "can refer to one common platform and talk about it". The powerful tool of accessing the internet for students' engaged learning in the computer lab is what she found wonderful about the current technology and resources. This led to the positive student results at the end of MVT project, thus researchers could get her buy-in to stay on for the follow-up project. Researchers acknowledged Victoria's contributions and discussed with Victoria about the iMVT approach to teaching Science to students of the different schools during the interviews and subject group discussions.

Secondly, we look at the existing and researcher-built resources as part of the structure: Victoria's role as a senior teacher and how researchers optimize her capacity. Under the teachers' network set up by the Ministry of Education (2001), senior teachers go through a rigorous process of observations and interviews before being appointed. They should embody deep subject knowledge, and create good learning environments and values for students in their character development. With such experience, it is easier for Victoria to mentor new teachers for the use of iMVT. In order to optimize her capacity, the project team invited her to be one of the mentor teachers of the MVT II project and the director of the National Institute of Singapore presented the mentor teacher certificate to her at the project launch ceremony. Coordination of time is a challenge to overcome in a scaled up project with different school teachers' schedules as well as teachers' priority of teaching needs over research demands. To overcome this constraint, researchers created an online wiki forum to allow Victoria to lead teacher discussions online. From this virtual community of teachers we also hoped to examine different teachers' initiatives in contributing to discussions and their efforts in the project.

After going through the first round of MVT integration, Victoria succinctly identified factors that a teacher needs to succeed in teaching the iMVT pedagogy to help teachers "weave in this new technology into [their] teaching". We facilitated a mentor teacher's views like these to be shared by suggesting venues for her sharing with the other participating school teachers. Victoria presented her experience during teacher-researcher workshops and subject group discussions to guide newly joined teachers. Her experience helped guide newly joined teachers from a practitioner's point of view and reduce potential problems during the implementation stage. Furthermore, Victoria took this opportunity to motivate the Physics teachers to share project findings with other teachers in Singapore by aiming for the biennial Teacher's Conference organized by MOE. Through such events, teachers' work can be recognized by sharing good teaching practices nationally or even internationally. Teacher testimonials like this should convince more teachers to adopt the iMVT pedagogy.

5. Discussion and Implications

After presenting Victoria's case of sustaining and scaling in the iMVT pedagogy, we can understand better how her beliefs and knowledge of the opportunities versus constraints helped her to adopt, sustain, and scale up an technology integrated innovative pedagogy iMVT. Researchers enabled and supported the teacher in demonstrating her agency. We argued that this was beyond other 'train the trainers' approach by forming a community of teachers led by the mentor teacher who has the knowledge and skills to transform this iMVT teaching. The community operated through online, face to face, and other ways of communication. Our results will help inform the literature on how existing structures and enabled structures promote teacher agency the adoption of an innovative pedagogy like iMVT.

Due to space constraint, we have not been able to unpack Roger's Diffusion of Innovation theory (Rogers & Olaguera, 2003) in terms of teachers' stages and development in adopting an innovation. We will also look at the effectiveness of this model of mentoring in sustaining and scaling by tracking the new teachers' changes in beliefs about iMVT. Furthermore, we hope to find out what have both mentor teachers and new teachers discovered about themselves and their strategies to sustain and scale up their use of iMVT.

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以科技接受模式探討高等教育學生使用學習管理系統進行數位學習之態度和意圖

Higher Education Students' Attitude and Intention towards Using Learning Management Systems: A TAM Case Study

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【摘要】本研究以科技接受模式 (Technology Acceptance Model, TAM) 探討高等教育學生使用學習管理系統進行數位學習之態度和意圖，包含認知輔助過程、系統特性、認知有用性、認知易用性、使用態度、使用意圖等六個主要構面之分析，而學習管理系統以在台灣市佔率最高的智慧大師 (Wisdom Master, WM) 為例。本研究以問卷調查方式進行，問卷內容分成三大部份，包含：個人背景資料、實際使用智慧大師情形、開放式問項，研究對象為曾用智慧大師進行數位學習的高等教育學生，含大學生與碩、博士班學生。本研究提出八個假設，再以皮爾森相關法 (Pearson Correlation) 和路徑分析法 (path analysis) 加以驗證，得知構面間具有相關性，所有研究假設皆成立，且達到顯著水準；最後，我們統計使用智慧大師各種功能的頻率，發現與課程直接相關的學習資源 (如：上傳作業和下載課程資料) 最常被使用。

【關鍵詞】科技接受模式、學習管理系統、數位學習、智慧大師。

Abstract: In this study, Technology Acceptance Model (TAM) is applied to analyze higher education students' attitude and intention towards using Learning Management Systems (LMS). Our TAM consists of six major constructs, namely, the cognitive instrumental process, the LMS quality, the perceived usefulness, the perceived ease of use, the attitude towards using LMS, and the behavioral intention. To gather empirical data, we designed a questionnaire with three parts, including the personal profile, the experience of using LMS, and open items. Our samples were 155 higher education students, including undergraduates and graduates. We used Pearson correlation and path analysis to verify the relationships among our proposed eight hypotheses. Analysis results had revealed the significance of each hypothesis. Also, both homework uploading and data downloading were the top two frequently used functions.

Keywords: Technology Acceptance Model (TAM), Learning Management System (LMS), E-learning, Wisdom Master.

1. 緒論

數位學習是資訊時代的一大趨勢，不僅提供新的教學模式與知識傳遞管道，也引領學習管理系統 (Learning Management System, LMS) 蓬勃發展，透過多媒體內容與技術，人們可以設計多樣化的學習管理系統。一般而言，學習管理系統具有全方位的管理平台，且擁有重複使用性、取得容易性、互相通用性、耐用性等特質。因此，不斷提升學習管理系統各項價值，是進行數位學習的重要前提；而探究學習者對於學習管理系統的接受態度和行為意圖，作為更新系統的參考，並提供教師設計教學內容與活動之建議，應是使用學習管理系統進行數位學習前，值得我們探討的關鍵議題。Davis (1989) 提出科技接受模式 (Technology Acceptance Model, TAM)，在許多領域中已成功探討使用者對不同類型資訊系統的接受程度，亦受到廣泛的驗證。綜合上述，本研究以科技接受模式，探討高等教育學生使用學習管理系統進行數位學習的態度和意圖，希望藉此研究結果，提供學術界與實務界參考。

2. 文獻探討

2.1. 學習管理系統

學習管理系統 (Learning Management System, LMS) 不侷限於時間與空間，可與傳統面授教學互補，並依個人需求給予適性化學習資源，提升教學與學習成效。世界各地學校常用的學習管理系統包括：Blackboard、WebCT、Moodle 等；在台灣常見的學習管理系統包括：企業學習線上 (ELN)、勢能學習網院 (CNELN)、Good2u、CTMS、智慧大師 (Wisdom Master, WM) 等，其中智慧大師被台灣百家大專院校和企業採用，市佔率高達七成以上 (蕭勝文，2008)。

2.2. 科技接受模式

Davis (1989) 提出科技接受模式 (Technology Acceptance Model, TAM) 是目前最常用於探討使用者對新的資訊科技接受度的理論模型，包括五個主要構面，含：外部變項、認知有用性、認知易用性、使用行為態度、使用行為意向等，除了上述五個構面，可加上預測日後實際使用行為的構面。科技接受模式由認知有用性 (Perceived Usefulness) 與認知易用性 (Perceived Ease of Use) 兩個概念組成，用以解釋、診斷、預測使用者面對新資訊科技時行為。

為提升科技接受模式對使用者行為之預測與解釋能力，Venkatesh & Davis (2000) 將原本科技接受模式加以延伸，提出科技接受模式二 (TAM 2)。TAM 2 加入四個社會性影響變數 (社會影響過程) 和三個影響認知系統有用的變數 (認知輔助過程) 作為外部變項。其中，認知輔助過程是指人們對認知有用的判斷，亦即系統是否有足夠能力完成他們的需求，其構面包括三個變項：工作關聯、輸出品質和結果展示性 (Singletary et al., 2002; Ozag, 2004)。此外，Delone & Mclean (1992) 提出資訊系統成功模式 (Success Model)，他們發現一套成功的資訊系統必須具有的特徵：良好的系統品質和資訊品質、高度的使用者滿意度和系統使用率。

3. 研究方法

3.1. 研究架構與假設

本研究擬定研究架構：分別探討個人背景資料、認知輔助過程、系統品質、認知有用性、認知易用性、使用態度和使用意圖等關係，並提出下列八個假設：

- H1：智慧大師認知輔助過程會影響使用者對智慧大師的認知有用性。
- H2：智慧大師特性 (系統品質和資訊品質) 會影響使用者對智慧大師的認知有用性。
- H3：智慧大師特性 (系統品質和資訊品質) 會影響使用者對智慧大師的認知易用性。
- H4：使用者對智慧大師的認知易用性會影響使用者對智慧大師的認知有用性。
- H5：使用者對智慧大師的認知易用性會影響使用智慧大師的態度。
- H6：使用者對智慧大師的認知有用性會影響使用智慧大師的態度。
- H7：使用者對智慧大師的認知有用性會影響使用智慧大師的意圖。
- H8：使用智慧大師的態度會影響以智慧大師製作數位教材的意圖。

3.2. 研究對象與資料處理分析

本研究的問卷調查分為預試問卷與正式問卷等兩階段。設定對象為高等教育領域中具有使用智慧大師經驗的學生。在預試階段，本研究選擇 24 位具有智慧大師進行數位學習課程經驗的碩士班學生為樣本；正式問卷對象包含大學生與碩、博士班學生，共計 155 位。預試問卷與正式問卷皆經過信效度分析：信度檢驗採用 Cronbach's α ；效度以項目分析檢驗量表問項，並以遺漏值、平均值、標準差、偏態、相關和因素負荷量等六項指標進行評估。本研究採用「相關法」及「線性迴歸」，於正式問卷以假設間自變數與依變數相互影響關係為目的，統計方式以皮爾森相關分析法 (Pearson Correlation) 和路徑分析法 (path analysis)。

4. 結果與討論

4.1. 個人背景資料

本研究的個人基本資料共計六項，包含性別、年級、使用電腦的年資、使用電腦的感覺、使用智慧大師頻率和參與數位學習的興趣等，如表 1 所示。

表 1、個人背景部份之次數分配描述與百分比統計。

變項	性別		年級		電腦年資 (年)			覺得電腦			智慧大師頻率			數位教材興趣			
項目	男	女	大學	碩博	0~5	6~10	10 以上	容易	尚可	困難	偶爾	普通	經常	沒有	沒意見	有	非常
樣本數	81	74	99	56	16	64	75	110	43	2	45	87	23	4	33	81	37
百分比	52.3	47.7	63.9	36.1	10.3	41.3	48.4	71.0	27.7	1.3	29.0	56.1	14.8	2.6	21.3	52.3	23.9

4.2. 實際使用智慧大師情形

本研究採用皮爾森相關分析法 (Pearson correlation) 探討各變項間的相關程度。表 2 表示研究構面間的相關性，包括認知輔助過程、智慧大師特性、認知有用性、認知易用性、使

用態度、使用意圖等六個構面，可知各構面間皆有高度相關性，其中相關係數最高之構面為使用態度與使用意圖高達 0.919 (表 2 中以粗體表示)，可知使用者以智慧大師進行數位學習的態度，正向影響使用意圖；其次，認知易用性與智慧大師特性之相關係數則為 0.900，顯示系統品質和資訊品質是影響使用者主觀的認知易用性相當重要的因素。其餘構面間也皆呈高度相關，且達顯著差異 ($p < .001$) 的水準。

表 2、研究構面間相關性。

構面		認知輔助過程	智慧大師特性	認知有用性	認知易用性	使用態度	使用意圖
認知輔助過程	Pearson 相關	1	-	-	-	-	-
	顯著性 (雙尾)		-	-	-	-	-
智慧大師特性	Pearson 相關	.863	1	-	-	-	-
	顯著性 (雙尾)	.000***		-	-	-	-
認知有用性	Pearson 相關	.834	.890	1	-	-	-
	顯著性 (雙尾)	.000***	.000***		-	-	-
認知易用性	Pearson 相關	.790	.900	.854	1	-	-
	顯著性 (雙尾)	.000***	.000***	.000***		-	-
使用態度	Pearson 相關	.848	.895	.892	.852	1	-
	顯著性 (雙尾)	.000***	.000***	.000***	.000***		-
使用意圖	Pearson 相關	.826	.869	.841	.806	.919	1
	顯著性 (雙尾)	.000***	.000***	.000***	.000***	.000***	

路徑分析 (path analysis) 是一種以模式化的方式進行變項關係分析的統計技術，目的是從變項之間的共變關係，檢驗所提出的影響、預測、或因果關係。本研究依據理論文獻提出路徑模型，表 3 表示研究構面間的路徑參數與研究假設，而迴歸係數 β 和顯著性則用以預測構面間解釋程度，顯著水準以 * 表示是否達顯著性，若 β 值達顯著性，則代表該研究假設的預測度為直接效果影響。圖 1 表示研究之路徑分析圖，顯示本研究所提出的八個假設皆成立，路徑分析法的預測度皆達顯著差異 ($p < .01$) 以上，且構面間有直接效果的影响。

表 3、研究構面間路徑分析參數與研究假設。

自變項	依變項	假設	β 係數	顯著性	成立與否
認知輔助過程	認知有用性	H1	0.834	***	成立
智慧大師特性	認知有用性	H2	0.639	***	成立
	認知易用性	H3	0.900	***	成立
認知易用性	認知有用性	H4	0.278	***	成立
	使用態度	H5	0.332	***	成立
認知有用性	使用態度	H6	0.608	***	成立
	使用意圖	H7	0.205	**	成立
使用態度	使用意圖	H8	0.826	***	成立

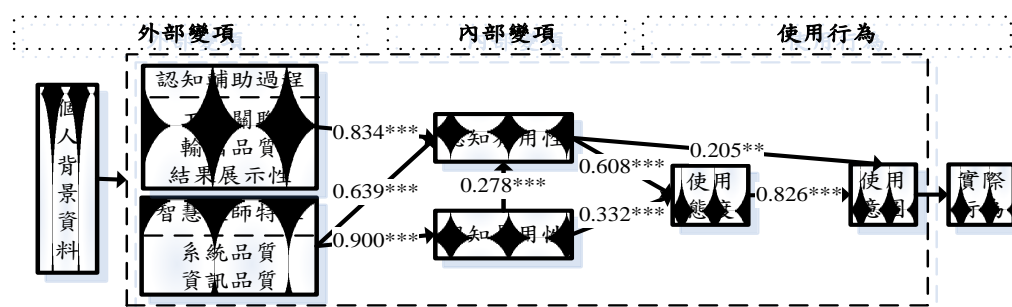


圖 1、路徑分析圖。

4.3. 開放式問項

「開放式問項」包括：最常使用哪些智慧大師功能和學習資源，以及除了以智慧大師進行數位學習外，還會以智慧大師進行哪些活動？圖 2 表示智慧大師各種功能與資源的學習使用頻率，其中最常被使用的功能或學習資源依序為：上傳作業 (130 人)、下載課程資料 (113 人)、觀看課程公告 (80 人) 和最新消息 (62 人) 等；另外，使用者還會以智慧大師進行視訊會議、小組討論、課程點名、分享、留言板等活動。

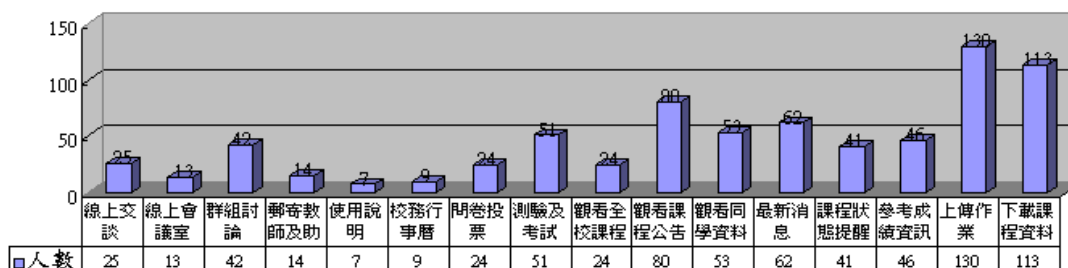


圖 2、智慧大師功能與學習資源使用頻率之長條圖統計。

5. 結論與建議

本研究以科技接受模式探討高等教育學生使用學習管理系統智慧大師進行數位學習的態度和意圖，衡量之六個主要構面包括：認知輔助過程、系統特性、認知有用性、認知易用性、使用態度、和使用意圖，提出以下結論：

- (1) 構面間具有高度相關性且達顯著水準，其中使用態度與使用意圖高度相關高達 0.919，可知使用者正向態度是影響使用者行為意圖相當重要的因素。
- (2) 本研究八個假設皆成立且達顯著水準，得知認知有用性和認知易用性扮演中介變項角色，認知輔助過程和智慧大師特性可以藉由中介變項間接影響使用行為（態度和意圖）。
- (3) 根據使用者使用智慧大師的功能頻率，可以得知：與課程相關的學習資源最常被使用，依序為上傳作業、下載課程資料、觀看課程公告和最新消息等功能。

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Construction of Innovative Teacher Education Community towards Pre-service and In-service Teachers

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Abstracts: *The purpose of this study is to explore the new teaching and learning platform for the field of teacher education. The integration of information and communication technologies (ICT) in the pre-service and in-service teaching & learning process is progressively being acknowledged as a vital and necessary step forward. How to use ICT technology to solve practical problems of teacher education is the key of this research. Innovative teacher education community (ITEC) which focuses on solving the learning problems has been designed for students not on the campus, as well as for teachers' mutual development. The paper stresses the ITEC is effective in monitoring and recording processes of teaching and learning.*

Keywords: Teacher Education, ICT, ITEC, Community, Pre-service and In-service Teachers

Introduction

Teacher education is the foundation and source for educational development. Teacher education refers to the policies and procedures designed to equip prospective teachers with the knowledge, attitudes, behaviors and skills they require to perform their tasks effectively in the classroom, school and wider community (Wikipedia, 2009). The integration of information and communication technologies (ICT) in the pre-service and in-service teaching & learning process is progressively being acknowledged as a vital and necessary step forward (Carol O., 2008). To achieve this, it is well recognized that Teacher Educators need professional development, not only in technology skills and applications, but also in new pedagogical methods of incorporating technology into the classroom. (Carlson & Gadio 2002; Snider, 2003).

The research is funded by the Chinese Development and Reform Commission "Application Demonstration of Teacher Education Innovation Platform Based on IPv6 Technology" Program. How to use ICT technology to solve practical problems of teacher education is the key of our researches. Innovative teacher education community (ITEC) has been put forward under this condition. ITEC focuses on three aspects for enhancing the quality of learning and training of teacher education, that is to say, it provides network teaching-assisted resources and environment for the normal school students; provides distance learning resources and environment for in-service teachers, provides in-service training for teachers. Actually, combined with conventional and innovative tools compatible with current web technology, ITEC can support well-know, well-tested techniques, and also enable implementation of new and innovative teaching and learning activities in a web-based environment (Denis H., Harald K., Hermann M., Nick S., 2005).

The designing of ITEC

Needs analysis

Blackboard, WebCT, Moodle, OLAT and ITEC, which are of a lot of features typical for e-learning platforms, are widely used in many countries and institutions, but are not designed for the field of teacher education. These platforms are not designed for focusing on solving the problems of the field of teacher education. Teachers are faced with such a severe challenge that current systems can't adapt to the ever-changing classroom teaching. So, we absorb the experiences and advantages of the current platforms, and integrate the special needs of teacher education into the ITEC to form a prototype for discussion. After several workshops, the features of ITEC have been determined. The process of ITEC developing will be planned according to development research.

Feature and structural design

To achieve inter-school teacher education course resources sharing, the system focuses on solving the speed and stability issues. High-quality course resources will be migrated to IPv6-based environment for maximized sharing. The target users are mainly free normal students, "4+2 (four years undergraduate and two years postgraduate learning) students" and Master of Education candidates. Thus, ITEC is a powerful teaching and course management system. In this section, it describes six main components of ITEC (Shown in Figure1.).

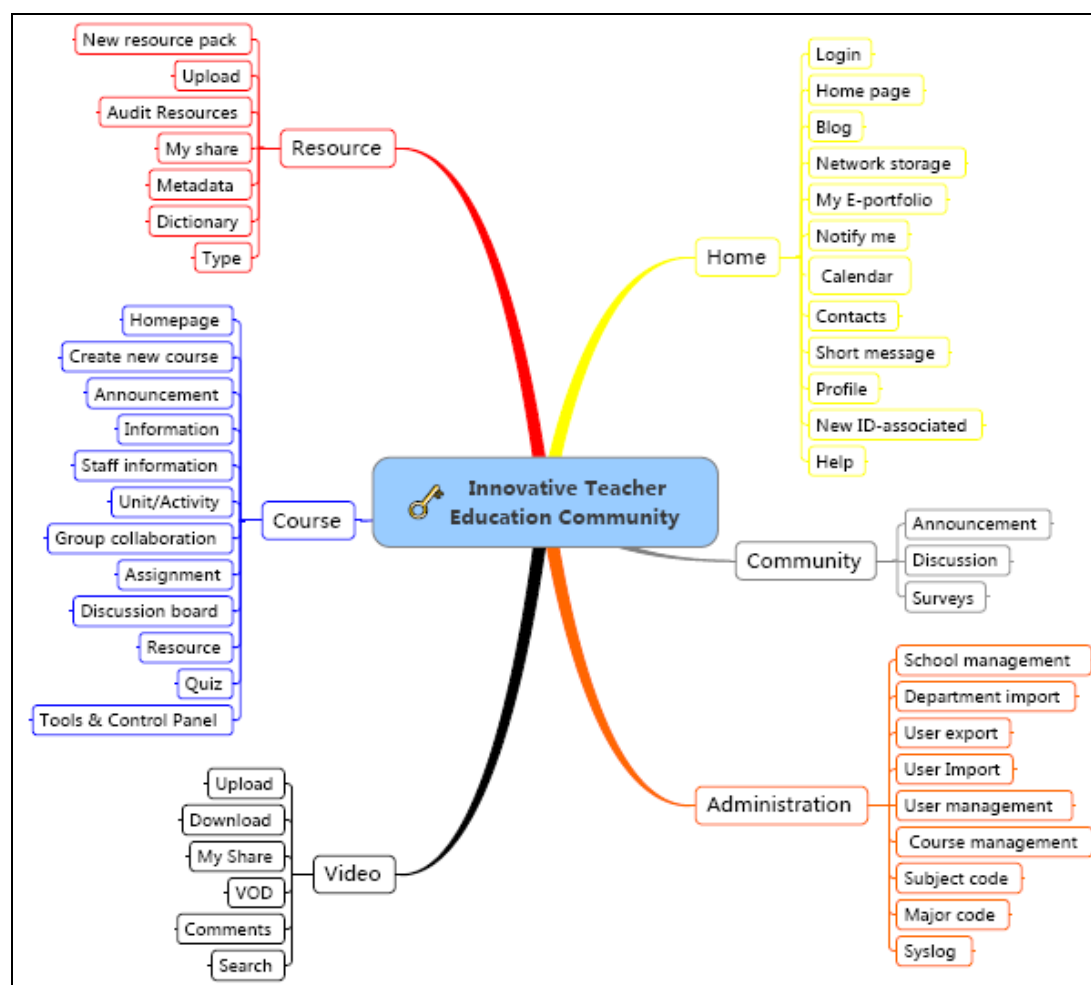


Figure1. The architecture of ITEC

The home module is considered as a personal space. It is a private space for users' to store learning and teaching resources, send and receive short message and post a new log in blog space.

The course module is the core part of ITEC. After login in the platform, different roles have different permissions in course module. Generally, if the teacher clicks the course module, she/he can create a new course first. Then, she/he can use the tools providing by the platform to construct the unit, activity, assignment, quiz, discussion, and so on. Teachers upload some useful resources though the resources list. Of course, if the teacher does not like the current menu in the course module, she/he can solve the problem though modifying the name of the menu. If the teacher wants to construct the course according to the requirement of the National Quality Course, her/ his needs will be realized perfectly with the help of course module. Its functions not only support the web-based teaching and learning, but also provide menu selection to construct the Quality Course.

The resource module provides a large space for sharing resources. Everyone can upload and download documents or files from and to local drives; such as text, images, video, audio, etc. This way avoids the drawbacks of traditional information sharing mode.

Video module is the sub-module of the resources part. Video resources use the red 5 technology which support streaming play. This is crucial to maintain full speed when large numbers of users are accessing simultaneously.

Community module, as public information services module, provides an announcement board for users accessing the public information, a discussion board for discussing and interaction. The administrator can release Questionnaire through the survey menu.

The administration module contains the teaching affairs and system administration. In order to ensure platform security and effective management of users, administrator has the permissions of auditing the courses, users, resources. The system access numbers can be viewed through the system log.

Cases of innovative application

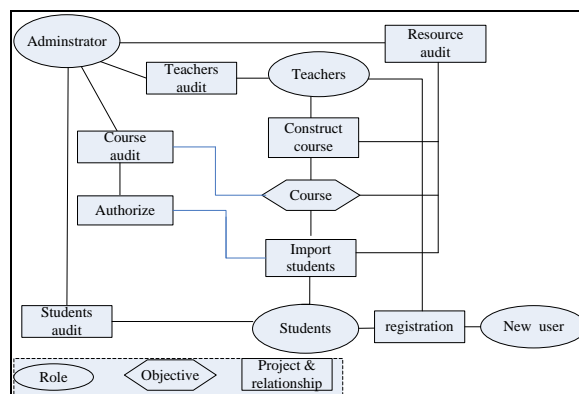


Figure2. The workflow of ITEC

After six months, the ITEC platform (beta) has been developed by our team. Through a pilot study, about 3-month, the platform forms a simple workflow of using ITEC, which is shown in Figure2. While working on ITEC, the administrator imports the users' information into the teaching affairs module. Then the new user should associate with the information first, and then create an account. If teachers login the system, they can create course, edit contents, upload or share resources.

In order to support teaching and learning effectively, ITEC provides five tasks (assignment, quiz, group collaboration, case study and discussion board) for teachers to monitor the teaching process and students to achieve their goals. The control panel and tools as an auxiliary management part help teachers manage members, schedules and results book.

All the users can upload, download, collect, and view the metadata of any files. If the resource does not meet the requirements, it will be shielded by the administrator.

Although the case described above is a simplified process, it demonstrates the mechanism of innovative teaching and learning process.

Evaluation

Evaluation is essential for demonstrating the feasibility and effectiveness of ITEC. It provides feedback information to adjust the design of ITEC and to make its function better (Manu K. & Charles K. K, 2007). Interviewed with the participants, ITEC supports the following behaviors:

- ITEC builds the innovative teacher education community environment as cognitive tools. It abandons sole purpose of conventional web-based instruction platforms.
- It has been found that many teachers and students hope they can use ITEC for blended teaching and learning, and doing teamwork. ITEC makes some breakthrough progress for instruction.

Conclusion

This paper has described and evaluated an innovative teacher education community environment which is used for the field of teacher education, the target users are pre-service and in-service teachers, normal universities. The purpose of designing and developing the platform focus on solving the learning problems that the students are not on the campus, as well as for teachers' mutual development. Thus, ITEC can be seen as an application of ICT to promote pre-service and in-service teacher development. We believe this is a topic pertinent to the field of educational technology and thus merit further research.

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基於 Web2.0 概念之學校組織知識管理系統建構

Constructing a Knowledge Management System of Elementary School Based on Web 2.0

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【摘要】 本研究提出以 Web 2.0 概念為基礎之 KMS(Web 2.0 Knowledge Management System, W2KMS)平台。系統設計運用 Web 2.0 概念及技術，建立使用者為中心之網路平台，透過轉移自部落格(BLOG)的管理概念及使用界面，快速導引學校組織成員的知識管理動作結合於日常任務之中，使用者以簡單輸入的方式將知識輸入於知識庫中，以此概念導入學校行政及教學事務工作之中，透過 W2KMS，讓使用者自行編輯學校行政、教學文件、超連結的提供或檔案的分享，讓校園的網站不再是以往單純的 Web1.0 行為模式，透過 Web 2.0 的社群概念，讓組織成員成為知識平台的知識提供者，充分利用網路智慧的潛在價值，並且利用 RSS 讓使用者即時獲得其關注的資訊，有助組織成員間的知識擴散。

【關鍵詞】 Web2.0、知識管理系統、小學

Abstract: The purpose of this study is to develop a web-based Knowledge Management System (W2KMS for abbrev.) based on web 2.0. The W2KMS adopts the management concept and user interface from blog, so the members of school organization can handle their knowledge management of daily administrative and instructional tasks easily under the W2KMS including instructional design, teaching materials, administrative documents. The members can share their knowledge or access knowledge resources from the W2KMS. To reach the function of knowledge proliferation, the W2KMS employs RSS technology to offer the real-time knowledge for their members. The W2KMS was tested and launched in an elementary in Taipei city. In the future research, we will survey the effect of W2KMS.

Keywords: Web2.0, KMS(Knowledge Management Systems), Elementary school

1. 研究動機與目的

網路科技發展，從 Web 1.0 演變至今的 Web 2.0 概念。Web 2.0 應用特色具有「分享和參與的架構，所驅動的網路效應」、「拉動長尾的能力」等關鍵原則(O'Reilly 和 Battelle, 2005)，使用者能便捷地在網路上輕鬆分享知識，使得資訊以驚人速度累積，進而造成知識爆炸。Web 2.0 概念在生活中越趨普及，人們漸漸因某些因素聚集成社群，形成網路基礎下的豐富資訊、知識的分類。學校組織的知識類似於長尾效應中銷量小、種類多的產品，透過 Web2.0 的參與、互動、共享、形成群體智慧等特性，轉化知識蓄積及擴散模式，在組織效能上必能造成知識的長尾效應。

Alavi 與 Leidner(2001)認為知識管理系統對於顯性知應以建立知識庫的方式儲存管理，隱性知識則透過資訊科技建立知識網路予以傳播，有效促使知識的創造循環。Shulman(1999)提出知識不會因使用而消耗，相反的透過分享與知識交換，才能促成知識的成長，廣義來說知識管理是知識累積、匯集及有效應用，狹義而言知識管理是透過資訊科技使知識大量的累積、儲存、移轉、實施而成知識管理。王如哲(2000)認為教育人員的專業知識成長是決定教育領域知識的進展關鍵，在教育組織流程之中，建構增進隱性知識和顯性知識的互動程序和機制，促使教育組織的知識螺旋型成長持續進行。吳清山(2001)指出學校知識管理的平台包括 Web 化

介面、應用軟體、資料庫、管理系統、電腦及相關配備等五大基本的設施，對於學校推動知識管理相當重要。吳清山(2001)進一步指出知識管理與學校效能存在著「知識管理是提升學校效能的重要手段；行政效能和教學效能的提升，需要借助於資訊科搬和知識管理」等重要的關係，因此，發展學校組織的知識管理平台是推動效能的重要策略及作為。但學校組織推動科技化知識管理，受限於成員的科技知能，導致知識蓄積困窘，知識不能快速累積及有效擴散，自然無法帶動組織成長及蓄積知識的能量。簡易的資訊系統，使用者不必受限於科技操作能力，讓組織專注於知識內容的提供、累積及應用，而部落格正是一項尚符合此條件的Web2.0 工具。部落格包含 RSS、迴響、引用、部落格連結和文章匯整等功能(Curling, 2001)，由於使用便利性，低科技應用門檻，部落格在學校組織的教育應用上更趨廣泛，研究者所服務之學校單位，行政人員、教師、學生、家長在長期部落格的資訊服務推動下，也已累積相當程度的教育應用經驗。但因部落格對內容管理權限功能的不足，使其應用在組織的知識管理可行性降低，若能有一知識管理系統，具備部落格操作的簡易性，卻有強化的管理權限以及更符合學校組織知識管理功能的特性，將有助於知識管理的效能。

結合以上 Web2.0 概念以及知識管理平台對學校效能的意涵，本研究以導入其概念，建構易於操作、重視知識傳遞功能的知識管理平台，透過簡單輸入的方式將知識輸入於知識庫中，使知識管理動作結合於組織日常任務，提升學校組織行政效能、教學效能，並結合 Web2.0 特有的 RSS 及非即時性的 email 傳遞知識，促進組織內知識擴散。

2. 研究設計與規劃

為了將 Web 2.0 導入學校組織知識管理系統，提升學校效能，我們提出了一個 W2KMS(Web 2.0 Knowledge Management System)平台，其架構圖如圖 1 所示，說明如下：

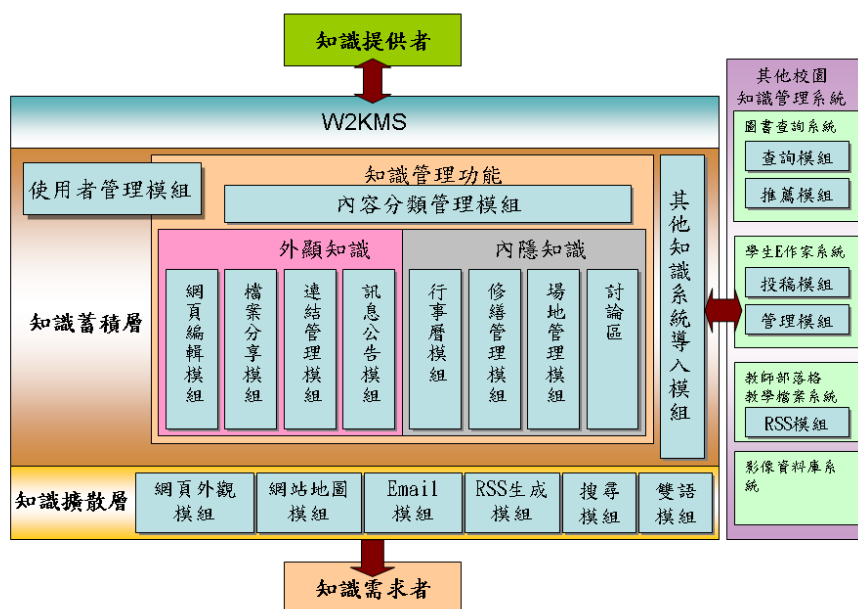


圖 1、系統架構圖

3.1 W2KMS 操作界面

W2KMS 採用與許多部落格相似的線上編輯器做為知識輸入界面，簡單易學的文件編輯方式，既可降低使用者資訊教育訓練成本，兼具加速知識產生的作用。操作界面如圖 2。

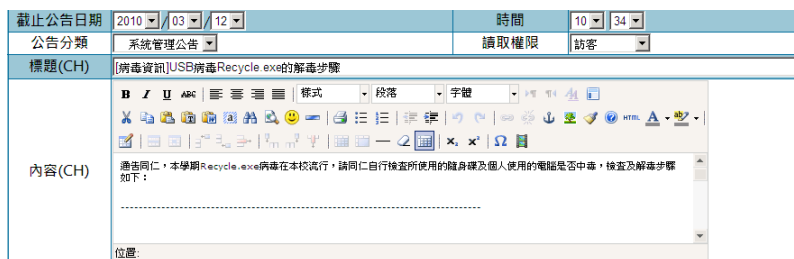


圖 2、W2KMS 操作界面

3.2 Modules in W2KMS

W2KMS 系統設計的目的主要是讓組織成員能透過容易操作的界面，彙整組織知識系統、快速擴散知識，使用者透過此系統各模組功能達到更效率的知識蓄積及擴散目的：

- (1)「使用者管理」功能包含身分確認、新增使用者、資料管理、權限設定等使用者管理模組，將使用者權限由高至低分為七等級，高權限可閱讀低權限設定之知識內容。
- (2)「知識蓄積」功能包含內容分類管理、網頁文件編輯、檔案分享(如圖 3)、超連結管理、訊息公告、行事曆、修繕管理、場地管理、討論區等模組，提供組織成員進行知識的編寫、儲存及分類整理等累積組織知識功能，系統可依據內容分類自動建立知識結構樹及動態網站地圖，並具有同步郵件通知的訊息公告功能。知識可透過行事曆儲存工作流程或彙整組織行事安排等隱性知識轉化。系統將修繕事務需求及結果彙整輸出為報表檔案，縮短管理流程及做為彙整事務性之隱性知識外化。場地管理模組除管理組織內場地運用及分配之功能，同步將需求排入組織行事曆，使隱性知識蓄積的效能提升。

導覽>> 首頁>> 檔案中心



圖 3、檔案中心

- (3)「知識擴散」功能包含網頁外觀、動態網站地圖(如圖 4)、Email 傳遞知識、組織知識 RSS 生成、知識搜尋等模組，提供知識需求者獲取組織外顯知識的功能。系統提供多樣的使用界面，動態生成網站地圖，讓知識需求者便於依據網站地圖提供的知識樹狀分類獲得知識，且系統自動讀取各成員已設定之電子郵件地址發送最新訊息，增進知識擴散的速度，系統提供能切換不同語文知識內容的閱讀界面，滿足知識需求者之語言需求。



圖 4、動態網站地圖暨知識搜尋、RSS 新聞分類畫面

- (4)「其他系統導入」功能將校園其他知識管理系統導入 W2KMS，利用 RSS 串連校園內其他的知識管理系統或讀取資料庫，整合組織內部的知識資源，以個人化需求為導向，依據不同使用者需求而提供所訂閱的最新資訊或知識。

3. 系統之初期應用分析

本研究依據上述模組實作呈現之平台，如圖 5 所示，架設簡易的學校組織知識管理平台，透過組織內知識蓄積及擴散，促進組織成員知識分享及成長，提升學校效能。



圖 5、W2KMS 平台

本研究已於臺北市一所中型國民小學實施 3 年，該學校組織有 102 位教職員工，目前知識提供者仍以該組織教師及教育行政人員為主，截至本文發表為止，該組織累積的知識成果，知識總閱覽人數超過 1,071,243 人次，累積的知識內容計有網頁文件 123 篇(點閱人次 519,786 次)、訊息公告 4394 篇(點閱人次 551,457 次)、檔案 3,852 件(下載次數 1,095,004 次)、超連結 407 項、組織成員累積登入次數 10,391 次。

4. 結論

隨著 Web 2.0 概念廣泛使用，科技的運用越趨強調人際互動及群體智慧。希望透過本研究建置的學校組織知識管理平台的簡易操作模式及各項知識管理工具的應用，提供學校組織內的教育行政人員、教師、學生、家長經由單一的知識入口，激發知識的互動，進而活絡學校組織的效能，延續知識的傳承與創新。平台使用量上知識總閱覽人數超過 100 萬人次以及 1 萬次以上的組織成員累積登入次數，已成為該學校組織重要的知識管理平台。

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台灣大專院校教師參與數位學習人才訓練評鑑之研究

A Study of e-learning Training Evaluation for Taiwanese College Faculty

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【摘要】數位學習蓬勃發展，對現今大學的教與學有重大影響，所以培養大專院校數位學習專業人才，以提升大學生學習成效，為當務之急。本研究針對台灣教育部數位學習人才培訓課程，取樣參與的 16 位現職大學教師，以 Kirkpatrick 四階段評鑑模式，分析這些教師的部落格日誌，以評估教師在參與數位學習人才訓練的狀況、滿意度、在知識、技能與態度上的轉變，以及對於實際教學的效能。研究發現教師對於訓練過程、結果基本上是滿意的，並藉由彼此心得分享、學習，在知識、技能與態度上皆有所提升。

【關鍵詞】數位學習、課程訓練、Kirkpatrick 評鑑模式

Abstract: With the vigorous growth of e-learning, it is important to develop e-learning professionals in universities. This study was a qualitative research, using content analysis method to collect and analyze 16 faculties' data based on the 4-level Kirkpatrick model of training evaluation. Evaluation measures how the faculties in a training program react, assesses the extent faculties have advanced their knowledge, skills or attitude, and predicts the changes of their teaching. The results show that the faculties' reaction to the training is basically satisfying and their knowledge and capability are improved through sharing and learning with each other. Finally, faculties have started to think how to apply the knowledge in teaching and inspire the e-learning atmosphere in the organizations.

Keywords: e-learning, course training, Kirkpatrick evaluation

1. 緒論

台灣教育部除了積極鼓勵大學設立教學資源/支援中心，提供教師必要的協助外，也需要培養各大專院校數位學習專業人才，開設各種數位學習的課程，以期望能透過人才培訓，協助各大學數位學習之發展。本研究欲了解大專院校教師在參與數位學習人才訓練的狀況、滿意度，探究參與教師在新知識、技能與態度上是否有轉變，以及對於實際教學的效能是否有幫助。數位學習教育訓練目標是期望教師能應用資訊傳播科技工具，設計課程與單元活動、追蹤學生學習進度等。學員在訓練的過程中，透過實體上課與網路平台，實際體驗教學活動，並在訓練結束時，設計網路課程。為了解訓練成效，本研究所採用Kirkpatrick 四階段評鑑模式，並藉由大專院校教師所撰寫部落格內容蒐集，來分析培訓課程是否有達到預期標準，以改善未來教育訓練內容與方向之參考。

2. 訓練評鑑與 Kirkpatrick 評鑑模式

Kirkpatrick四層次評鑑模式可說是被廣為使用的評鑑模式(Kaufman, Keller & Watkins, 1995)。在2002年ASTD的標竿論壇中一研究報告顯示，參與該研究的企業中，做到「反應」層次者占88.9%，做到「學習」層次者占27.9%，做到「行為」層次者占13.2%，做到「成效」

層次者則僅佔4.3%。目前關於教育訓練評鑑多以企業為主，較少有大專院校教師教育訓練評鑑，此外探究教師教育訓練評鑑又多以問卷法，少有以質化方式探討。本研究以整理教師部落格日誌的方式，深入探討大專院校教師教育訓練的成效，及在教學現場的改進，並且期望透過運用評鑑結果的資訊，來改善下一次的訓練，才能達成訓練評鑑的目的與功能，做為將來設計教育訓練課程之參考。

3. 研究方法

本研究採用部落格內容分析法，分析大專院校教師在數位學習專業人才培訓過程中每週所撰寫的部落格，內容主要包含了教師學習態度與心得，以及對該培訓課程的回饋。研究對象是台灣教育部數位學習人才培訓課程共50名學員，取樣16位現職大學教師中，分別來自台灣16所大學，男女各8位，其中10位教師於北部大學授課，中部3位，南部2位，東部1位，教授的科目包含電腦、電子、英文、藝術、歷史等，這16位教師在大學任教年資都超過5年。

4. 研究發現

從部落格的日誌可看得出來，大部分的學員對於數位學習教育訓練結果都給予正面的回應，對於訓練團隊的努力表達感謝。學員並深切體認到數位學習於高等教育運用時，須以學習成效及品質為重，並希望能學以致用，持續投入相關領域的研究及實作。

學員在教育訓練後，對於數位學習的態度、知識、技能都有提升、改變。從學員的部落格日誌來看，學習者透過教育訓練，與其他學員、老師、助教互動，對訓練內容做整理，教學反省，不時做自我修正，也透過問題的釐清與實際做中學，建立對數位學習的正確觀念與態度，也提升自己的知識與技能，數位學習教育訓練對於大專院校教師在「學習」層次確實有很大的幫助。然而教學行為的改變需要長時間觀察，在「行為」層次的評鑑需要長時間追蹤，才能了解教師訓練不足的地方，以改進位來的訓練方案。訓練成效方面，學員回去與其他同事分享訓練的心得，也開始嘗試設計線上課程，來幫助學生學習。

5. 討論與結論

本研究以大專院校教師為研究對象，以 Kirkpatrick 四層次評鑑模式為基礎，以教師部落格日誌進行研究，目的在於了解教師訓練之情形。總括來說，大專院校教師在對於數位學習人才訓練的過程與結果基本上是滿意的，教師透過設計不同領域的網路課程，彼此交換心得，互相學習，更加了解教學理念、活動設計，因此在知識、技能與態度上也有改變、提升。藉由實際設計課程的經驗，學員也開始思考如何將所學應用於教學，並且將這學習經驗與同事分享，預期會帶動組織從事數位學習的氣氛。

本研究針對來自台灣各地的大專院校教師，評鑑其參與教育訓練的結果，從結果可以看出教師面對數位學習的新方式，都保持著相當的熱誠，教育訓練雖未能盡善盡美，學員也對課程提出改進建議，以其對下次課程有許多成長進步空間，教師回到任教學校，在數位學習上能發揮所學。在未來研究面向上，可針對大專院校教師教育訓練評鑑進行長時間的追蹤，更深入了解他們實際教學的情況。

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數位學習品質發展國際趨勢探討

Investigating eLearning Quality Development Trends from International Perspectives

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【摘要】 現今很多國家都有從事數位學習品質研究或推廣的機構，開始注重數位學習品質，本文以文獻回顧法並透過訪談，廣泛蒐集國際間數位學習品質相關認證業務或頒發品質獎項的資料，並重新分析、整理，主要探討歐洲國家與美國、加拿大主要數位學習品質授予標章制度與營運方向，從中找出國際間品質機構目前的發展模式以及數位學習品質界與國際接軌的方法。

【關鍵字】 數位學習品質、品質認證、品質標章、品質標準

Abstract: There are many eLearning quality organizations in the world putting much effort on quality research and quality promotion. In this research, literature review and interview approach were adopted to make a depth and breadth analysis on eLearning quality certificates and awards, and organizational business models. In order to find a general pattern of awarding quality marks and organization development trends, European, United States, and Canadian eLearning quality organizations were analyzed. The purpose of this research was to find a general pattern on recent quality organization development and eLearning quality international cooperation approaches.

Keywords: eLearning quality, Quality certificate, Quality mark, Quality criteria

1.前言

數位學習 1.0 的廣播式教學邏輯隨著發展，進階至數位學習 2.0 的參與式意象，數位學習品質的角色，也從檢核與控管轉化為促進學習歷程的啟動器(Ehlers, 2009)。在新時代中，品質聚焦在改變多於控制，發展多於確保，創新多於遵守(Ehlers, 2009)。本文以當今世界各國主要數位學習品質機構為主題，深入研究歐、美主要的數位學習品質機構，廣泛分析各機構在業務與研究型態上的模式，並將其分析做成綜合結論，目的為找出數位學習品質機構成功營運的模式與未來可行的國際合作模式，盼能為亞洲數位學習品質界帶來整合的力量與願景。

2.數位學習的品質把關者

歐洲研究指出，大學、研究機構、中型規模組織、數位學習提供者視數位學習品質為最佳的學習成效(best learning achievement)，另一方面，公司、企業，提供成人教育訓練的組織則視數位學習品質為符合基本的標準，並具備市場、利潤導向 (Ehlers, Goertz, Hildebrandt, &

Pawlowski, 2005)。目前國際間的數位學習品質組織的主要研究對象也大致分成這兩大類型。

2.1 國際數位學習品質機構營運狀況分析

研究結果得知美國訓練發展協會的 e-Learning Courseware Certification 小組，簡稱 ECC、英國、加拿大的 eQcheck、與台灣品質認證中心都以數位學習品質認證為主要業務，向申請單位收取認證費用之收入如不足以負擔組織本身的營運支出，又未獲得外界財力支援時，組織很容易因經費不足或業務減少而停止營運。ECC 小組已於 2008 年 12 月 31 日結束營運。

2.2 國際數位學習品質單位授予標章分析

Pawlowski (2007)指出，品質標章是一種透過評鑑達到特定標準的認證方式，對內提升員工的執行品質，對外提高市場價值。研究顯示，美國訓練發展協會，英國、加拿大的 eQcheck (Barker, 2007)，與台灣品質認證中心偏重市場導向的認證，而歐洲數位學習品質基金會的提升目標則是高等教育的數位學習品質，芬蘭數位學習協會則學術與市場各半。國際上執行數位學習相關認證或頒發獎項的組織單位，認證的方向從小範圍的課程轉變成以認證單位、機構為主。變化原因為：一，送審件數變少，製作完整的數位教材成本高，blended-learning 教學模式興起。二，web2.0 與 rapid eLearning 提供了多元、有效率且有趣的教育訓練模式。

3. 數位學習品質國際交流合作

品質認證的精隨是要被越多人接受，才能擴大其效益，提高本身的價值(Ehlers, Goertz, Hildebrandt, & Pawlowski, 2005)，國際間的品質單位相互承認品質標章對於業者的國際行銷也有助益。未來發展可以建立跨國之數位學習品質共識為方向，建立國家之間的認證平台，對於產業之國際推廣將會有實質的幫助。品質界的交流方式可分成兩項，與學術研究單位合作，做業務與研究方向的分享與合作，建立研究人脈。也可與通過認證或是得到品質獎項的業界單位合作，以推廣數位學習產品的角度為主要方向，由品質單位協助業者進行國際推廣。

附注

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影響國小教師使用電子白板效能因素之研究

The Factors Affecting the Use of Interactive Electronic Whiteboard by Taiwan Elementary School Teachers

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【摘要】 台灣為了推動e化教學，大力推展互動式電子白板應用於教學中，以期提高教師的教學效能以及學生的學習成效，落實國民中小學課程綱要的精神。然而，目前有關教師對於電子白板融入教學的相關研究，仍較為缺乏。故本研究採取文獻分析及訪談法，蒐集整理互動式電子白板的相關文獻，探討教師使用互動式電子白板融入教學的效能因素，包括教學信念、教學方法與實際教學情況的瞭解，以期能作為未來後續相關研究的初步探究。

【關鍵字】 互動式電子白板、教學信念、教學效能

***Abstract:** In order to enhance teachers' teaching efficiency and students learning effectiveness, Taiwan government has prompted the integration of interactive electronic whiteboard into classrooms in recent years. However, related research on teachers' perception of employing interactive electronic whiteboard in their teaching is still limited. This study conducts literature review and teacher-interviews to collect related documents and to explore the possible factors (such as teachers' beliefs, teaching strategies and the practical condition) when employing interactive electronic whiteboard in the classroom teaching. Finally, this study discusses the future research directions.*

Keywords: interactive electronic whiteboard, teaching beliefs, teaching efficiency

1.前言

資訊通訊科技（Informational Communication Technology, ICT）的快速發展，影響了各級教育的發展方向，互動式電子白板（Interactive Whiteboard, IWB）便是這一波新科技產物。早在於1997年，英國便開始推廣互動式電子白板應用在教育上，近年來，台灣為了推動e化教學，從2007年起正式將互動式電子白板帶入教育現場。然而，目前關於電子白板等資訊科技融入教學之研究中，較少提及老師對於資訊科技融入教學的知覺，以及其本身教學信念及應用策略等相關探究，故本研究旨在了解國小教師本身的資訊能力是否會影響使用互動式電子白板的態度及學習策略，以及電子白板融入教室教學產生什麼效應，並試圖瞭解教師所持的教學信念及觀點與電子白板教學的關係等。

2.文獻探討

針對互動式電子白板之教學的意義、應用及相關研究進行探討。其應用互動式電子白板的教學特色，整理如下：輔助教學的多種功能、多重感官的學習型態、提高學生的學習動機、增進教師的教學效能（如陳惠邦，2006；周孝俊，2008；Chia-Ming Liu, Bo-Yen Wang, Yuan-Hsun Liao, Ming-Hsiang Su & Pao-Ta Yu，2009）。國內外有關互動式電子白板之研究文獻，正在逐

漸累積當中。然而，陳惠邦（2006）指出與互動白板有關的研究報告中較少是針對學生、中學教師、小學教師訪談的分析詮釋，涉及社會建構主義（Social Constructivism）之觀點，或是社會文化理論進行研究設計等相關研究。故本研究以訪談方式，從教師的觀點去探討互動式電子白板所帶來的教室教學影響。

3.研究方法

本研究採質性研究，主要方法為文獻分析及訪談法，蒐集整理互動式電子白板的相關文獻，以瞭解電子白板融入教學的現況，並透過深度訪談的方式，訪談三位國小教師，一名實習老師。每位老師訪談時間各約一小時，從 2009 年 11 月 6 日到 20 日止。訪問形式採半結構式，主要問題包括資訊能力、教學信念是否會影響使用互動式電子白板教學的意願，實際使用互動式電子白板教學對於教室教學的影響為何，教師本身對於使用電子白板的期待及看法。

4.研究結果與討論

研究者依據對教師的訪談內容，並針對下列幾點進行研究結果的討論如下：教師資訊能力多少影響使用互動式電子白板的意願，然而教學需求才是影響使用的主要關鍵；而教師對於互動式電子白板所持的教學信念，正面意義能有助於師生互動、提高教學效能，然而也可能過度依賴電子教科書而忽略了事前備課的重要性。另外，教師皆肯定互動式電子白板所帶來的正面意義，只是仍要注重學生基本能力的培養，亦不能過於依賴多元感官型態的學習，而失去純以圖文平面呈現的學習興趣。

5.結論與建議

利用互動式電子白板，是現今教學科技的新趨勢。然而，將互動式電子白板這一類的科技媒體帶入教育現場，教師本身對於科技接受度及認同感，才是資訊融入教學成功的關鍵所在。因此，本文彙整文獻及訪談，認為透過互動式電子白板的教學，促使學生為學習中心的教育理念，透過互動參與學習的方式，提高學生的學習動機及學習成效，亦有助於提升教師的教學效能。然而，教師的態度及理念是影響互動式電子白板是否能融入課堂教學的重要關鍵，值得我們重視及關注。目前台灣在推動互動式電子白板教學仍在起步的階段，而相關文獻研究亦在累積當中，故本研究提供實性、第一手之訪談資料，期能作為未來相關研究之參考。

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Knowledge Management in School Education: Reflections from a case study

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Abstract: *By adopting various knowledge management (KM) models, a school under investigation utilizes a web-based learning and teaching platform to embrace a miscellaneous collection of e-learning models and flexible learning tools such as e-books, concept-mapping software, interactive whiteboards and e-portfolios, social networking websites (like Facebook, Blogs), GPRS, m-learning devices (like I-pods and 3-G phones), web authoring software and multimedia resources. In particular, two action research projects were carried out in the school years 2007-2008 and 2008-2009 for testifying the exemplified KM models with stepwise leadership and management strategies for further school improvement.*

Keywords: e-learning, IT & school development, knowledge management

Introduction

The school under investigation is a local Direct Subsidies Scheme (DSS) private school located in Hong Kong, which promotes whole man and gifted education, in the ‘through-train’ mode of primary and secondary education by adopting an innovative eleven-year learning span, with unique and complimentary characteristics in international education (e.g. International Baccalaureate (IB) Diploma examination) perspectives. The primary section of the school working school has been initiated for six years, whilst the secondary section has started for five years. The school has two primary and secondary sections in two separate school premises. The number of students in primary section is about 1,800. The school creates new knowledge and skills, facing big challenges to new curricula and school syllabuses by testifying various conceptual models of knowledge management (KM) through action research (c.f. The State of Florida, 2008).

1. Theoretical Framework

Using web-based learning and teaching platform, four dimensions of Snowden (2000) for sustainable development of knowledge management (KM) are utilized to:

- Transform *tacit knowledge* into *explicit* one, regardless of the nature and orientation
- Transform *individual knowledge’s explicit knowledge* into *holistic* base
- Transform *individual knowledge’s tacit knowledge* into *holistic* base
- Internalize *applications of explicit knowledge* into *tacit one* for further conceptualization

The web-based learning and teaching platform in the school tends to embrace a miscellaneous collection of e-learning models and learning tools such as e-books, concept-mapping software, interactive whiteboards and e-portfolios, social networking websites (like Facebook, Blogs), GPRS, m-learning devices (like I-pods and 3-G phones), web authoring software and multimedia resources. For reducing resource costs, uses of various types of

freeware are maximized. An online school intranet system called 'e-class'² is used to *disseminate* administrative news and transform technical skills and share pedagogical knowledge. An online knowledge building (KB) platform called Knowledge Community (KC)³ is employed to help students brainstorm new ideas, analyze and criticize collected information and finally co-construct knowledge in project works on web authoring and multimedia resources (Bereiter & Scardamalia, 1993). Through public sharing of successful learning and teaching experiences using free Google Apps for Educators⁴ services and online technical supports services⁵, teachers' individualized knowledge can be further embodied into public knowledge domain and part of their useful *tacit* information like survey data and database design can be further constructed into *explicit* student learning dimensions. Reflections from action research in the school such as unifying departmental databases and establishment of e-learning platforms (*explicit knowledge*) can be conceptualized into theoretical models (*tacit knowledge*) for further teacher professional development and training within schools, experiential sharing with other school collaborators from Mainland China and presenting papers at local and international conferences. So key processes of *knowledge dissemination* and *knowledge embodiment* can be interchanged to one another through *uses of information technology for further construction of new knowledge* in learning and teaching dimensions in Demerest (1997)'s KM model.

In the aspects of corporate management strategy and electronic leadership, a knowledge management and knowledge building culture is fostered through a set of KM enablers (such as distributed and transformational leadership models, descriptive and evaluative research measurements, information technology and open democratic working culture) and KM processes of adaptation, collection, creation, innovations, sharing and organizations (Arthur Anderson Business Consulting, 1999). In the school, the principal allows lots of freedom and space for frontline teachers to teach and learn in catering for varying learning needs of students without any rigidity of school curricula or mode of educational assessment. Enthusiastic school teachers and subject panel chairpersons are highly motivated to devise their preferable modes of school-based curricula (SBC) at secondary and primary levels, despite lack of clear curriculum directions and program coherency at the system level. Such bottom-up approach is characterized by mutual understanding of the nature of SBC and non-linear, complex negotiated mechanisms of course delivery at the frontline teacher level. Notably, there is *no uniformity* in curriculum design across studying forms and subject departments. Curricula tend to be *subject-based* and *form-based*, catering for the students' varying learning needs. Subject teachers (usually one teacher for the whole studying form at subject level) are required to devise their lesson plans, teaching and learning resources by themselves. On evaluation, such subject-based curriculum development matches perfectly frontline teachers' value beliefs and avoids rigid, mechanical indoctrination of standardized school curricula.

2. Reflections on Action Research

For facilitating IT in school improvement in the school, a school-wide action research team has been established. Members were composed of three senior administrators (including the two authors as the *major researchers*), five academic department heads, two part-time consultants on quality assurance in teaching and learning, all the technical staff members of Computer and Information Technology (CIT) Dept. and some part-time research assistants in the school years 2007-08 and 2008-2009. Indeed, two undergoing action research projects on resource management are

² <http://www1.logosacademy.edu.hk/templates/>

³ <http://www.globalkc.net/>

⁴ <http://www.google.com/a/help/intl/zh-CN/edu/index.html>

⁵ <http://www.logosacademy.edu.hk/tss/>

depicted as follows.

2.1 Setting up online communication platform

In retrospect, about 120 teaching and administrative staff members in two separate (primary and secondary) school premises of the school often lack sufficient internal communications, resulting in operational or administrative inefficiencies, ineffective uses of teaching and learning resources, time clashes of student activities and internal staff meetings at inter- and intra-departmental levels. Based on this background, the main directions of the first action project / research were to find out feasible technical means to strengthen internal inter- and intra-departmental staff communications using online communication platform or other IT devices; and to maximize the uses of current teaching and learning resources through IT or to seek alternative non-IT solutions. Since 2007-2008, administrative departments and technical units, grouped into several newsgroups, are encouraged to use an online e-platform named 'e-class' at inter-departmental and intra-departmental levels for resolving such miscommunication problems.

Reflections on successive cycles of action research looked for improvements in:

- reducing serious mismatch between online booking items and borrowed or returning items in the facilities storage rooms and increasing working incentives for teaching staff to use e-class
- re-allocating those resources in locations, convenient to general teacher users and devising fruitful measures, besides using e-class, to maximize teaching colleagues' correct uses of those resources
- laying down logistic procedures for resigning staff to follow before their official leave and resolving thorny problems in departmental governance and resource shortage problems

An interim evaluation survey of 79 (45 male+34 female) teachers on their concerns and IT usage was conducted in fourth semester. Besides strengthening inter- and intra-departmental communications (16.46% strongly agree, 12.66% agree), e-class has helped some of those surveyed teaching colleagues to avoid time clashes between students' extracurricular activities and give online notice on time (36.71% strong agree, 13.92% agree), facing limited resources and large teaching workforce. Yet less than 30% of respondents *per se* agreed to use e-class to post i-mails, due to strong preference for using open global web-based mailing systems like gmail, hotmail, yahoo, instead of intranet-based mailing system. Another implication was that habitual socio-cultural factors such as preferable in-person communications (rather than online communication platforms) are not easily eradicated in short terms in staff communications. Besides using virtual communication platform on resource management, such action research infers some shortcomings on teacher professional development. More in-person social gatherings and staff development workshops are necessary for strengthening inter- and intra-departmental communications, instead of using IT methods like 'e-class'.

2.2 Fastening the process and generating correct student report cards

After about six years of operations, the school has still unresolved hard problems in delayed delivery and misprints of some student report cards throughout the semesters. Close interviews with key stakeholders found that the involved student database is not so *centralized* that various involved parties have its different versions without being updated, leading to serious data processing errors. Another action research was utilized to find out the underlying causes and thereby work out feasible solutions. The fruitfulness of the second action research is that more related causative factors

in school management, curricular development and teacher professional development can be articulated for further improvement. And there is an urgent call for establishment of centralized database system for the whole school.

3. Conclusions and Discussion

From current practical experiences, action research is very labor-intensive, requiring lots of resources and collegial collaborations. Practical difficulties were to call various involved parties to carry out logistic meetings and take follow-up actions after reflections. In reality, only a few were active in joining the two action research projects. Informal interviews and dialogues discovered that those 'passive' colleagues did not have positive attitudes towards action research or even were unfamiliar with action research procedures. To tackle such technical problems, introductory briefing of conception and procedures of action research was carried out at the beginning. Yet the involved administrative and teaching colleagues were busy carrying out other duties without paying full attention to the two projects. The two projects originated from resource management problems infer more insurmountable issues in teacher professional development, staff development and strategic leadership. For further extension of the two projects, more human resources (who believe in action research framework) and physical resources are required. Coherent workable items such as centralized database, staff training on action research and standardizing adjustments in school assessment related to the above problems and issues should be brainstormed in sharing sessions and drafted out in the new school annual plan in 2008-09 for further implementation of the exemplified KM models.

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Development and Validation of Online Knowledge-Sharing Motivation (KSM) Questionnaire

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Abstract: *The motivations of knowledge-sharing behaviors in online community remain unclear. The purpose of the study is to validate a previous questionnaire of online knowledge-sharing motivation (KSM). The confirmatory factor analysis (CFA) results confirm three online KSM, which are reputation, mutual benefit and rewards. The online KSM questionnaire positively identifies the adaption of the model in the digital setting, while differences exist in more delicate classification.*

Keywords: *motivation, online community, knowledge sharing, confirmatory factor analysis (CFA)*

1. Introduction

With the emerging technology of communication, daily interaction among people has been even more frequent than ever. While communication technology serves as the supporting tool and media and somehow changes the pattern of interaction, people operating in the community remain the crucial part (Davenport & Prusak, 1998). Online community members are from different background and have various reasons to participate in virtual community. The motivations of their sharing behaviors remain unclear. Previous research has identified several possible motivation of knowledge sharing behavior (Blau, 1964; Wasko & Faraj, 2005; Kankanhalli, Tan & Wei, 2005; Bartol & Srivastava, 2002; Bock, 2005) and the three most possible major motivation of online knowledge sharing might be reputation, mutual benefit and rewards. The three online KSMs were explored in Hsia and Chen's initial study (2008), but are not yet fully confirmed. The purpose of the study is to validate previous questionnaire of online knowledge-sharing motivation (KSM), to test if the identical motivation of knowledge-sharing in traditional setting also fit in online environments.

2. Method

The online anonymous questionnaire (Hsia & Chen, 2008) was used in this study. Items of this questionnaire include personal information, online community participation and engagement, and motivation of knowledge-sharing (reputation, mutual benefit, rewards). A total of 319 samples are valid. Analyses of the relation between motivation categories and questionnaire items were carried out to examine correlation. The analysis used the LISREL8.5 statistical software package. Descriptive statistics and reliability as a measure of internal consistency were both generated. Last, a confirmatory factor analysis (CFA) was conducted to test data-model fit of the motivation categories.

3. Results and Discussion

In the online knowledge-sharing motivation (KSM) questionnaire, item 11-14 contribute to reputation; item 16-20 contribute to mutual benefit; and item 23-25 contribute to rewards. The original item 15, 21 and 22 were deleted owing

to the lack of factor loading to any motivation category. The KSM model for the confirmatory factor analysis (CFA) is theoretically meaningful. The general model fit is acceptable and all remaining items present significant factor loading. Several goodness of fit indices are examined (RMSEA=0.070, SRMS=0.048, CFI=0.98) and the statistics indicate a moderate fit. The original structure of the motivation model is remained.

This present study basically examined the factorial validity of the literature-based online knowledge-sharing motivation model. The questionnaire items and constructs, derived from literature reviews and the previous study (Hsia & Chen, 2008), are tested well to fit online environments. The three major motivation, reputation, mutual benefit and rewards, in traditional environment are also identical in knowledge-sharing behavior in visual space. The results of the online KSM questionnaire positively identify the adaption of the model in the digital setting, which suggest the questionnaire is suitable for application in online community research. The adapted questionnaire of online knowledge-sharing motivation (KSM) is validated through the CFA results of the present study and could serve as a proper starting point for research on participation and engagement of online communities. Future works might need to more careful when dealing with the contextual and social-cultural issues of participants.

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線上運動討論區非正式學習型態量表之驗證性分析

The confirmative factor analysis of the informal learning instrument for online sports forums

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【摘要】在強調終身學習的時代中，非正式學習對成人來說是相當重要的學習管道。利用網路社群來進行知識分享和與他人互動，即屬於一種非正式學習的方式。本研究旨在編擬一非正式學習型態量表，並以 237 位線上運動討論區參與者為研究對象，驗證其因素結構。結果顯示，經過刪題後所剩的 19 題題項之多因子二階測量模式為最佳模式，且這 19 個題項可區分成「自我導向學習」、「偶發學習」和「社會化」等三個因素。

【關鍵字】線上運動討論區、非正式學習、驗證性因素分析

Abstract: In the age of lifelong learning, informal learning is a very important way for adults' continuous learning. To share knowledge and interact with others via online communities is one of the ways of informal learning. The purpose of this study was to develop and validate the Informal learning instrument (ILI) with 237 participants collected from several online sports forums. The results indicated that the developed ILI are validated with 19 items left and composed of three factor structures, self-directed learning, occasional learning and socialization.

Keywords: Online sports forums, informal learning, confirmative factor analysis

1. 前言

目前非正式學習相關的研究多著重在職場中員工的非正式學習行為或動機(例如吳淑娟, 2003; 李藹慈, 2006; 王桂卿, 2004; Linington, 2000), 對於虛擬社群或線上討論區的中參與者的非正式學習型態之研究為數不多, 適用的量表問卷也頗為缺乏, 或僅止於摸索理論結構的探索性因素分析。因此, 本研究旨在編擬一非正式學習型態量表, 並以線上運動討論區參與者為研究對象, 驗證其因素結構。

2. 文獻探討

非正式學習具有那些型態呢? 主要可區分成「自我導向學習」、「偶發學習」與「社會化」等三種型態。自我導向學習是指個人或團體在沒有教育者的協助之下, 有意圖且有計畫的去學習, 並懂得去尋找有用的資源資源 (Schugurensky, 2000)。偶發學習是個人碰到超出自己經驗所能理解的事物時, 藉由任務的完成、人際間的互動、或嘗試錯誤等方式所產生的一種學習, 而且當這樣的情形發生後, 個人通常會意識到自己正在進行學習 (Schugurensky, 2000; Marsick & Watkins, 2001)。至於社會化則是對價值、態度、行為、和技能等的內化, 是一種沒有計畫、潛移默化且不易察覺的學習經驗(Schugurensky, 2000)。

3. 研究方法與設計

3.1 研究對象

本研究以 18 個線上運動討論區之參與者為對象, 刪除廢卷後得到有效問卷共 237 份。

3.2 研究工具

研究者依據前述研究對的非正式學習型態定義編製題目後其中包含「自我導向學習」9 題、「偶發學習」7 題及「社會化」6 題, 共 22 題。此量表採 Likert 6 點量表, 分數越高, 表

示研究參與者越認同該項目為其在線上運動討論區所進行之非正式學習型態。

3.3 統計分析

本研究之非正式學習之內涵與架構乃源自前人之研究與定義，因此適合利用驗證性因素分析進行量表之效化。在適配性指標的選擇上，本研究選擇整體適配性指標(χ^2 、SRMR、RMSEA 及 GFI)及比較適配性指標(CFI)來驗證模型架構是否具有理論意義性，且所有被估計的參數都需達到統計上之顯著水準(Klein, 2005; Yu & Yu, 2007)。

4. 研究結果

根據 Kline(2005)的建議，當進行測量模式(measurement model)的檢驗時，即便多因子的適配性指標合宜，仍要進行單因子的模式檢驗。因此，本研究除了依照理論檢驗非正式學習型態的三因素，另將單因子模式作為比較(結果摘要請見表 1)。

表 1 四種模式之適配性指標

	未刪題之單因子 測量模式	未刪題之多因子 二階測量模式	刪題後之單因子 測量模式	刪題後之多因子 二階測量模式
χ^2	652.41	542.10	389.58	293.80
df	209	206	152	149
χ^2 / df	3.12	2.63	2.56	1.97
GFI > .90	.80	.83	.85	.88
CFI > .90	.89	.91	.94	.96
SRMR < .08	.083	.078	.065	.057
RMSEA < .10	.095	.083	.081	.064

5. 結論

綜合地來說，由表 1 可知，刪題後之多因子二階測量模式為最佳之模式，表示在線上運動討論區之非正式學習型態具有「自我導向學習」、「偶發學習」和「社會化」等三個因素。因為因素負荷量不達.3 而被刪除的 Y12、Y21 及 Y22，推測可能是因為線上運動討論區的非正式學習可能存在有目的性及無目的性的參與者，且因為文字為主的討論及社交方式，並非一定會有行為之改變影響，都可能是造成題目之不適用的原因。

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