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Evaluating the E-Learning Platform from the Perspective of Knowledge Management: The AHP Approach

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Abstract

A growing number of higher education institutions have adopted asynchronous and synchronous Web-based learning platforms to improve students' learning efficiency and increase learning satisfaction in the past decade. Unlike traditional face-to-face learning methods, e-learning platforms allow teachers to communicate with students and discuss course content anytime or anywhere. In addition, the teaching material can be reused via the e-learning platforms. To understand how students use e-learning platforms and what the implications are, we conducted an empirical study of the iCAN e-learning platform, which has been widely used in Fu-Jen Catholic University since 2005. We use the Analytic Hierarchy Process (AHP), a well-known multi-criteria evaluation approach, to compare five practices, i.e. the functions of the iCAN teaching platform. We adopted a brainstorming approach to design a questionnaire to measure *learners' perception of the e-learning platform* based on the theory of knowledge transforming process in knowledge management. Accordingly, the model considers functioning and objectivity in terms of the following three attributes of learning effectiveness: *individual learning*, *group sharing* and *learning performance*. Twelve criteria with twelve evaluation items were used to investigate the effectiveness of the five practices. We also evaluated the strengths and weaknesses of the functions based on the types of courses in the iCan platform. We expect that the empirical evaluation results will provide teachers with suggestions and guidelines for using the e-learning platform effectively to facilitate their teaching activities and promote students' learning efficiency and satisfaction.

Keywords: Analytic Hierarchy Process; E-learning Platform; Knowledge Management Functions; User's Perception

1. Introduction

The development of computer technology and the Internet has created opportunities for various kinds of profit and non-profit organization, such as government agencies, educational institutions and businesses, as well as individuals. Recognizing the power and convenience of the Internet, many organizations use the medium and information technology in their own networks. As a result, many highly successful and innovative business models have been established with the aid of Internet

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technology in the past ten years, e.g., B2B, C2C, B2C, on-line advertising, and blog Web sites. Furthermore, the emergence and rapid development of the World Wide Web has affected the most basic form of education, i.e., the traditional face-to-face teaching and learning model; therefore, leading the way of education has been influenced significantly (Chen, Kinshuk, & Wang, 2005; Yazon, Mayer-Smith, & Redfield, 2002). Chen et al. (2005) advanced a cyber-schooling framework that uses the familiar traditional school structure as its basis and attempts to enhance it through the use of technology to overcome the shortcomings of traditional education and study without the time and space restrictions. Also, Yazon et al. (2002) explored how technology may serve as a tool to change approaches to undergraduate teaching and learning as seen through the lenses of the academy's primary stakeholders. They both described the change in education that combines a traditional learning model and IT auxiliary learning construction.

Using information technology (IT) to support educational activities has become the trend in a wide range of applications (Shyamsundar & Gadh, 2001). Recently, a growing number of higher education institutions in Taiwan have adopted asynchronous and synchronous Web-based learning platforms to improve students' learning efficiency and increase learning satisfaction. The traditional teaching model is based on learning in a fixed location such as a classroom, which lacks mobility (Norris, Soloway, & Sullivan, 2002). Hence, it is not geared to exploiting all the advantages that current technologies have to offer (Chen et al., 2005; Riffell & Sibley, 2003, 2005). Apart from fixed locations (i.e., schools) that restrict various teaching activities, the traditional teaching model has other limitations. Additionally, the courses offered in school are taught at fixed times. Therefore, teachers and students have to interact at the same time and in a fixed location. Although the traditional face-to-face learning model facilitates direct communication between teachers and students, the fixed time for having classes are inflexible (Riffell & Sibley, 2003). Christensen, Harvard Business School's leading expert on industrial innovation, on predicted that "on present trends, 25 percent of all high school courses will be available online for everyone, of all ages, no later than 2014." Thus, it is very important that we determine how to combine technology and education to facilitate knowledge exchange across national boundaries without time constraints, i.e., e-learning. An increasing number of educational and business organizations are devoting more of their resources to e-learning and e-learning systems.

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In this study, we aimed to investigate the strength and weakness of different kinds of functions offered in the e-learning platform. We selected iCan as our research target, the main e-learning platform used by Fu-Jen Catholic University since 2005. Therefore, five types of practices (functions) are investigated in our questionnaire. We adopted a brainstorming approach to design a questionnaire to measure "*learners' perception of the e-learning platform*" based on the theory of knowledge transforming process in knowledge management (KM). KM is a cycle, a sometimes repeated process, which generally includes creation, management and sharing activities (Davenport & Prusak, 1998; Gray, 2001; Nonaka, 1994; Wiig, 1993). After discussions with two college teachers and several graduate students, the questionnaire considers three dimensions—individual learning, group sharing, and learning performance. To take one step forward, there are four items with associated statements for each dimension. Therefore, twelve criteria with twelve evaluation items were considered in order to investigate the effectiveness of five kinds of e-learning functions (practices). The participants in this study were students at Fu-Jen Catholic University who have used the iCan platform. Additionally, we will analyze the functionalities of different practices in the iCan platform based on types of courses, which include *technology*, *management* and *theory-based courses*. Consequently, we will analyze and explain the research results based on the course types. The results can give teachers useful suggestions and implications to effectively use e-learning platforms to help teaching activities and to promote students' learning satisfaction and efficiency.

2. Basic Concepts

2.1 Analytic hierarchy process (AHP)

The Analytic Hierarchy Process (AHP) is a well-known approach to resolving the decision-making problem about multiple criteria (Saaty, 1971). This method is an effective and practical approach that considers complex and unstructured decisions. The AHP systemically structures complex problems into a hierarchy and uses quantitative methods to evaluate alternatives that would help decision-makers choose the most appropriate solution. Atthirawong and MacCarthy (2002) proposed that there are three steps for considering decision problems through the AHP: constructing hierarchies, comparative judgment and synthesis of priorities. The first step is structuring the complicated problem into a hierarchy descends from an overall objective to various criteria, sub-criteria, and so on until the lowest level. The decision alternatives or selection choices are laid out on the last level

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of the hierarchy (Atthirawong & MacCarthy, 2002). AHP uses complete and incomplete hierarchy frameworks (Figure 1). The next step is determining the priorities of the elements at each level and developing the comparison matrix. Having made all the pair-wise comparisons, the consistency is determined by using the eigenvalue. The Consistency Index is as follows: CI=(λ_{max} -n)/(n-1) where λ_{max} is the eigenvalue and n is the matrix size. If each level's pair-wise comparison matrixes are in line with the required consistency, examination the consistency of the whole hierarchy. The last step is synthesizing priorities from the second level down by multiplying local priorities by the priority of their corresponding criterion in the level above and adding them for each element in a level according to the criteria it affects (Saaty, 1983).

We adopted the AHP approach to develop the framework used to evaluate the effectiveness of practices supported by the iCan e-learning platform. Therefore, we can obtain the weights of each dimension (i.e., individual learning, group sharing and learning performance) and the weights of criteria (i.e., items) of the associated dimension. There are some researches evaluating the e-learning platform by adopting the AHP approach. Chao and Chen (2009) utilize the consistent fuzzy preference relations (CFPR) in the AHP model to examine and summarize the key factors in order to rate the weights and evaluate the effectiveness of a distance e-learning system. The rating results provide teachers and decision-makers in schools with important information for improving e-learning practice in the future. Liu, Peng, Chen, and Xie (2009) further

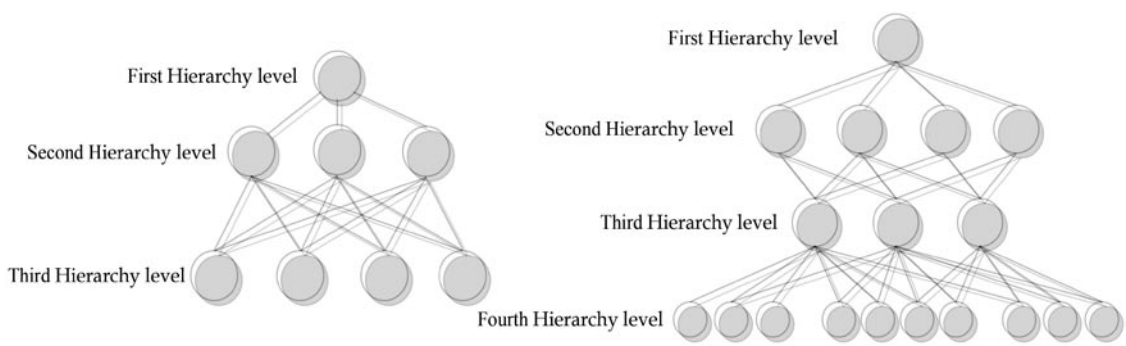


Figure 1. Complete and Incomplete Hierarchy Framework

Adapted from "A scaling method for priorities in hierarchical structure," by T. L. Saaty, 1977, *Journal of Mathematical Psychology, 15*(3), pp. 234-281.

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adopted the fuzzy AHP approach for the multi-criteria decision making problem of evaluating the effectiveness of the e-learning platform. Colace and De Santo (2011) propose a model for characterizing and selecting the e-learning platform. They formulate the quoted multi criteria problem, i.e., the e-learning solution selection, as a decision hierarchy to be solved using the Analytic Hierarchy Process (AHP). Finally, they showed the evaluate results and compare some existing commercial platforms. The above researches provide guidelines for the selection of the e-learning system. However, they did not develop the research framework from the perspective of knowledge management and knowledge management practices.

2.2 Model perception by fuzzy linguistic approach

As we know, it is hard to assess qualitative problems by using precise values, leading to the use of the fuzzy linguistic approach (Zadeh, 1965, 1975). The fuzzy linguistic approach is an approximating technique that could model human perception and help human decision-making. As Zadeh (1996) pointed out, linguistic assessment is one of the starting points in the computing with words (CW) concept in which words are used for computing and reasoning instead of numbers. Furthermore, the fuzzy number plays a fundamental role in formulating the semantic meaning of the linguistic term, which represents the approximate value of each linguistic term. For assessing the relevance degree between objects (e.g., document, task, etc.), the variable *Helpful* is defined and the corresponding terms–*very low, low, normal, high, very high, perfect*–are defined to express the context of *Helpful*. Notably, each linguistic variable is characterized by a quintuple (*S*, *E(S)*, *U*, *G*, *M*) as defined in Definition I, and each linguistic term is modeled by a triangular fuzzy number (TFN) as defined in Definition II.

Definition I (Klir & Yuan, 1995; Zadeh, 1975): A **linguistic variable** is expressed as a quintuple (*S*, *E(S)*, *U*, *G*, *M*) where *S* is the *name* of the variable; *E(S)* is the *linguistic terms* of *S*, that is the set of its linguistic values range over universe of discourse *U*; *G* is a *syntactic rule* (a grammar) that generates linguistic term set in *E(S)*; and *M* is a *semantic rule* that assigns meaning, *m(e),* to each linguistic term *e* in *E* with a fuzzy set on *U*.

Definition II (Dubois & Prade, 1978): A fuzzy number ${}^{\alpha}\tilde{Z}$ is a "normal" and "convex" fuzzy set defined on the set **R**, and $\tilde{Z}$ is a closed interval for every $\alpha \in (0.1]$. The membership function $f_{\tilde{Z}}(\chi)$ of the triangular fuzzy number (TFN) $\tilde{Z}=(l, m, r)$ is given below.

$$f_{\tilde{Z}}(x)=\begin{cases}(x-l)/(m-l) & l \le x \le m \\ (r-x)/(r-m) & m \le x \le r \\ 0 & otherwise\end{cases} \quad (1)$$

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This work adopts the center of area (COA) method to calculate fuzzy numbers, owing to its simplicity and practicability. The COA method calculates the fuzzy mean under uniform probability distribution assumption (Lee & Li, 1998; Liu, Wu, & Yang, 2005). If the fuzzy number $\tilde{U}$ is triangular, where $\tilde{U}=(l, m, r)$ the crisp rating can be derived by the equation: $CV(\tilde{U})=[(r-l)+(m-l)]/3+l$.

Lin (2010) developed a fuzzy evaluation model by integrating triangular fuzzy numbers and Analytic Hierarchy Process (AHP), i.e., a fuzzy AHP approach, for ordering the relative weights of website quality factors. Similarly, in Section 5.2, we combined the crisp rating of each dimension or criterion (i.e., perceptions of usage experiences) with the associated weight (i.e., perception of importance) to calculate the fuzzy score for ranking practices in e-learning platforms.

3. Research Objectives and the Framework

3.1 Research objectives

Gray and Chan (2000) advance a framework that seeks to categorize and integrate the creation, storage and propagation of knowledge into a single model on the view that the problem-solving process is a vehicle for connecting knowledge and performance. Knowledge can generate the value when it is used to solve problems, explore opportunities and make decisions. Therefore, many profit and non-profit organizations adopt learning platforms to promote the inner communication of knowledge. Also, schools adopt learning platforms to enhance students' learning quality. Thus, teaching platforms are becoming important and useful tools for supporting students' learning activities. In order to enhance the learning quality of students and push communication between students and teachers, many schools incorporated various kinds of teaching platforms and counseled teachers and students to use them. The development of e-learning platform paid more attention on technology aspects rather than on user-centered design issues so far (Granić & Ćukušić, 2011). In this work, we aim at evaluating the e-learning platform from the aspect of users' using experiences. Furthermore, the evaluation of learning platforms is a multiple decision problem. A learning platform has many different functions that need to be considered completely. Therefore, we adopt the Analytic Hierarchy Process (AHP), a multi-criteria evaluation approach (Saaty, 1977, 1983), to evaluate users' perceptions after using the learning platform. We adopted the AHP in this work due to the approach was superior to traditional questionnaire methods in representing human perceptions (Sato, 2005). The AHP not only

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gets the most important alternative but also ranks the results by conducting pair-wise comparisons for all estimated alternatives. We selected iCan as our research target, the main e-learning platform used by Fu-Jen Catholic University since 2005. To summarize, the steps of the proposed approach are as follows:

- We adopted brainstorming approach to design a questionnaire to measure "*learners' perception of the e-learning platform"* based on the theory of knowledge transforming process in KM. Accordingly, three dimensions are considered in the questionnaire. They are individual learning, group sharing, and learning performance.
- We aim to investigate the strengths and weaknesses of different kinds of functions offered in the e-learning platform. We selected iCan as our research target; therefore, five types of practices (functions) are investigated in our questionnaire. They are homework, discussion board, material download, chat room, and learning index.
- To understand the functionalities of different practices offered in the iCan platform for types of courses, we will analyze and explain the empirical evaluation results based on the course types and the users' using experiences.

3.2 The research framework

We adopted the AHP approach to develop the framework used to evaluate the effectiveness of functions in the iCan e-learning platform, as shown in Figure 2. We designed three directions from the perspective of the knowledge management system, which are: individual learning, group sharing and learning performance. Each dimension has its own associated criteria; for example, the individual dimension comprises *independently learnin*g, *information usage*, *finding answers to questions* and *exploring new issue* criteria. In this research, we also evaluated the functionalities of different e-learning functions (practices) offered in the iCan platform for different types of courses. We selected three types of courses, which are technology, management and theory-based courses. We explain each criterion briefly as follows.

Individual Learning: Individual learning is defined as students who can build knowledge and experience personal growth through individual reflection and through their interactions with the others and the environment (Forcheri, Molfino, & Quarati, 2000). In this work, we focused on how students employ the e-learning platform to achieve individual learning. For example, students can download and review the materials, deliver homework,

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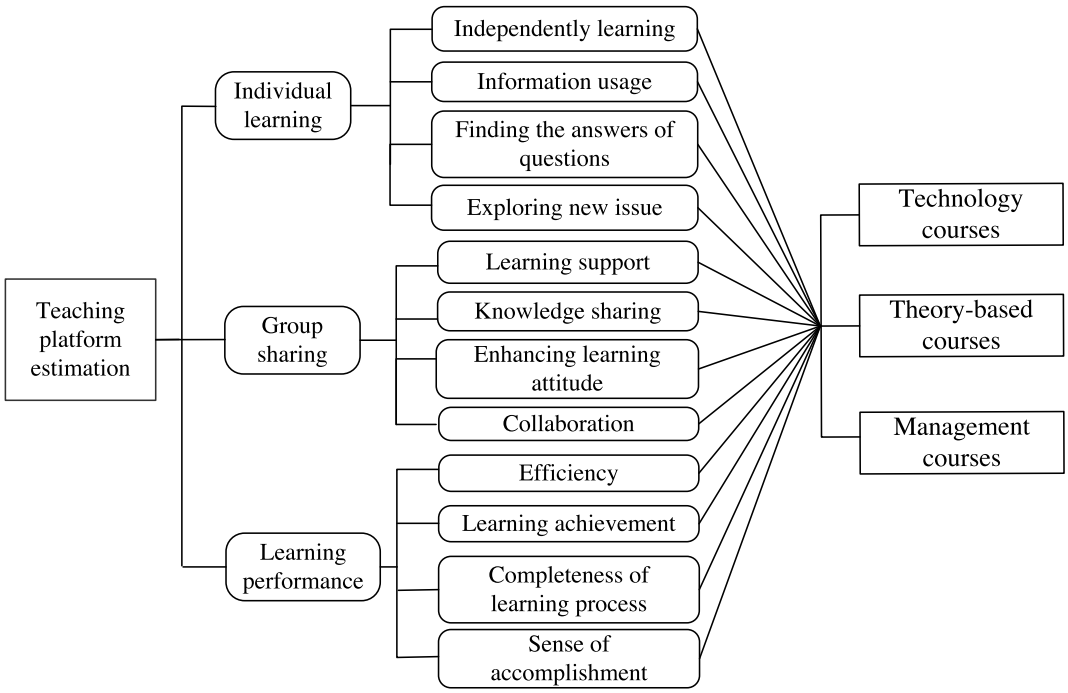


Figure 2. Hierarchy Framework of Effectiveness of Evaluating the E-learning Platform

or do the quizzes on the learning platform. Specifically, we use four criteria to evaluate the dimension of individual learning. They are *independently learning*, *information usage, finding the answers of questions*, and *exploring new issues*.

Group Sharing: Group sharing is defined as students working in a group to complete a specific task, make decisions or solve problems. The e-learning platform is a good technology for education to facilitate communication and collaboration for better knowledge sharing (Beckman, 1990; Johnson, Johnson, & Smith, 1991). The difference between traditional learning and e-learning is that students can talk face-to-face in traditional learning. It is synchronic. On the other hand, with e-learning, students can share their thinking via the functions in the platform; sometimes it is synchronous and other times it is asynchronous. For example, a chat room is a function that allows students to discuss to each other synchronously, while a message board helps students discuss issues asynchronously. In this work, we use four criteria to evaluate the dimension of group sharing. They are *learning support*, *knowledge sharing*, *enhancing learning attitude* and *collaboration*.

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Learning Performance: Learning performance may be measured by quantitative factors such as course grades or the time to search required data, or qualitative factors such as a sense of accomplishment or achievement (Patterson & Hobley, 2003). It is an essential part of learning, and it is quite important for students and teachers to evaluate the learning and teaching results. In this paper, we use four criteria to evaluate the dimension of learning performance. They are *efficiency, learning achievement, completeness of learning process and sense of accomplishment*.

Table 1. Statements of the Criterion

Evaluative dimensions	Criteria	Statement
Individual learning	Independent learning	Obtaining the ability to acquire the knowledge of courses by themselves successfully.
	Information usage	Gaining the capability to apply knowledge learned from the platform.
	Finding the answers to questions	Obtaining the ability to discover answers of existing questions.
	Exploring new issue	Exploring new issues from the learning process at the learning platform.
Group sharing	Learning support	Gaining the teaching support by communicating with instructors on the learning platform.
	Knowledge sharing	Sharing information and knowledge within the learning group in the platform. The learning contents and processes can be enriched.
	Enhancing learning attitude	Enhancing learning attitudes and enriching the learning contents by group learning processes.
	Collaboration	Improving the participation in team project.
Learning performance	Efficiency	Increasing the efficiency because of the ease of finding the information from the platform.
	Learning achievement	Increasing the testing score and evaluation grade.
	Completeness of learning process	Achieving the completeness of learning process more easily.
	Sense of accomplishment	Obtaining a sense of achievement by resolving the problems from the learning platform.

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4. Evaluation Setup

In this research, we designed the questionnaires to determine the students' perceptions of the e-learning platform for different kinds of courses. We talked with two professors and several graduate students to design the questionnaires. We will describe each investigation issue from the results of the questionnaire.

4.1 Determining evaluation dimensions and criteria

We separated the questionnaire into two parts. The first part is a pair-wise comparison estimation that compares the importance of every criterion. The questionnaire sample is shown in Figure 3. The participants check the boxes by importance. After we retrieved the completed questionnaires, we constructed a pair-wise comparison matrix and obtained the consistence index to ensure the consistency of the questionnaires. The data will show the importance of each dimension and criterion, i.e., weight; the greater the weight, the more important the dimension or criterion.

4.2 Ranking functions in e-learning platform

We chose five functions of iCan (homework, discussion board, material download, chat room and learning index) and adopted the fuzzy linguistic approach introduced in Section 2.2 to obtain the estimative score of each function. Each function in the e-learning platform supports different knowledge management practices. In this work, we use two terms, practices and functions, interchangeably. The score represents the degree

AHP Questionnaire Sample

1. Please rank the importance of the three dimensions at first.

☆_____Individual learning (**IL** for short)
☆_____Group sharing (**G** for short)
☆_____Learning performance (**LP** for short)

2. Please make pair-wise comparisons

	Absolute		Very-strong		Strong		Moderate		Equivalent	Moderate		Strong		Very-strong		Absolute		
	9 : 1	8 : 1	7 : 1	6 : 1	5 : 1	4 : 1	3 : 1	2 : 1	1 : 1	1 : 2	1 : 3	1 : 4	1 : 5	1 : 6	1 : 7	1 : 8	1 : 9	
IL																		G
IL																		LP
G																		LP

Figure 3. The AHP Questionnaire Sample

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of each practice supporting each criterion. The five functions and statements were shown in Table 2. Based on the result of the second part of the first questionnaire, we can get the score of each criterion, analyze the scores, and understand participants' viewpoints of every criterion.

4.3 Data collection

First, we selected the courses offered in Fu-Jen Catholic University's College of Management as the investigation target. In addition, the lecturers who are the top 50 login users of the iCan platform are another criteria used to select the target courses for evaluation. Finally, we selected courses that belong to one of three types of courses—technology, management or theory-based courses. In technology courses, we chose Java 1 and Java 2 as our investigative objects. Fifty questionnaires were returned. Removing ineffective questionnaires, we were left with 36 effective questionnaires. The return rate was 72 percent, as shown in Table 3(a). In management courses, we chose "Special Topic on MIS" and "Knowledge Management" as our investigative objects. Twenty-six questionnaires were returned. Removing ineffective questionnaires, we have 24 effective questionnaires. The effective return rate was 92 percent as shown in Table 3(b). In theory-based courses, we chose "Data Structure" and "An introduction to computers" as our investigative objects. There are 54 return questionnaires. Except ineffective questionnaires, we have 31 effective questionnaires. The effective return rate was 57 percent as shown in Table 3(c). We adopted some rules to select the three types of courses. For technology courses,

Table 2. The Evaluation Functions of iCan Learning Platform

Number	Function	Statement
1	Homework	Deliver homework: Students can upload their homework before the deadline. Homework observation: Students can inspect and learn from each other's homework.
2	Discussion board	Students and teachers can communicate with each other on the discussion board.
3	Material download	Students can download the course material.
4	Chat room	Students can communicate just-in-time in chat room.
5	Learning index	It shows the learning history on the platform, including the log-in times, the summary of discussion and material download and the situation of the homework delivering.

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Table 3(a). The Information of the Participants in Technology Courses.

Return questionnaire	*Effective questionnaire*	*Effective return rate*	*User information*			
			Sex		*Experience*	
50	36	72%	Male	18	Less than1 year	31
					1－2 years	3
			Female	18	2－3 years	2
					More than 3 years	0

Table 3(b). The Information of the Participants in Management Courses

Return questionnaire	*Effective questionnaire*	*Effective return rate*	*User information*			
			Sex		*Experience*	
26	24	92%	Male	17	Less than 1 year	2
					1－2 years	16
			Female	7	2－3 years	0
					More than 3 years	8

Table 3(c). The Information of the Participants in Theory Courses

Return questionnaire	*Effective questionnaire*	*Effective return rate*	*User information*			
			Sex		*Experience*	
54	31	57%	Male	18	Under 1 year	27
					1－2 years	2
			Female	13	2－3 years	1
					Over 3 years	1

we selected programming-based courses because it is more individualistic in nature. For management courses, we selected the courses had team works which can stimulate knowledge sharing and collaborative activities. For theory-based courses, we selected the core and fundamental courses of information management.

5. Evaluation Results

This research established the framework to evaluate the effectiveness of an e-learning platform according to the AHP approach. Therefore, we can obtain the weights of each dimension (i.e., individual learning, group sharing and learning performance) and the weights of criteria (i.e., items) of the associated dimension. Also, we chose five practices

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designed in the iCan learning platform as the evaluation cases to investigate the participants' perceptions of using them based on the established research framework. This section consists of five subsections: (1) determining evaluation dimensions and criteria, (2) ranking practices in the e-learning platform, and (3) discussions and implications.

5.1 Determining the weight of evaluation criteria

5.1.1 Evaluation results

The following section will show and describe the evaluation results. Table 4 shows the criteria with the associated weights of the three types of courses.

- For technology courses, the first three important criteria are information usage (C_{12}), independent learning (C_{11}) and efficiency (C_{31}). The less important criteria are enhancing learning attitude (C_{23}) and collaboration (C_{24}). All criteria belong to the group sharing dimension.
- For management courses, the first three important criteria are knowledge sharing (C_{22}), learning support (C_{21}) and information use (C_{12}). The less important criteria are sense of accomplishment (C_{34}) and collaboration (C_{24}).
- For theory-based courses, the first three important criteria are independently learning

Table 4. The Weight of Each Criterion of Three Courses for Evaluating the E-learning Platform

Criteria	*Technology courses*	*Management courses*	*Theory courses*
C_{11} Independent learning	**0.144(2)**	0.088(7)	**0.189(1)**
C_{12} Information use	**0.145(1)**	**0.110(3)**	**0.149(2)**
C_{13} Finding the answers to questions	0.115(4)	0.091(5)	**0.103(3)**
C_{14} Exploring new issues	0.055(9)	0.063(8)	0.053(9)
C_{21} Learning support	0.084(5)	**0.113(2)**	0.084(6)
C_{22} Knowledge sharing	0.051(10)	**0.121(1)**	0.044(10)
C_{23} Enhancing learning attitude	0.029(12)	0.045(10)	0.024(12)
C_{24} Collaboration	0.038(11)	0.080(11)	0.033(11)
C_{31} Efficiency	**0.126(3)**	0.098(4)	0.099(4)
C_{32} Learning achievement	0.068(7)	0.089(6)	0.086(5)
C_{33} Completeness of learning process	0.077(6)	0.052(9)	0.065(8)
C_{34} Sense of accomplishment	0.068(7)	0.050(12)	0.071(7)

Note. The numbers in ( ) mean the order of each course.

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(C_{11}), information usage (C_{12}) and finding the answers to questions (C_{13}). All criteria belong to the individual learning dimension. The less important criteria are collaboration (C_{24}), and enhancing learning attitude (C_{23}). All criteria belong to the group sharing dimension.

Table 5 shows the weights of three dimensions after summarizing the weight of each criterion.

- For technology courses, the most important dimension is individual learning (C1); the other important dimensions are learning performance (C3) and group sharing (C2).
- For management courses, the most important dimension is group sharing (C2); the other important dimensions are individual learning (C1) and learning performance (C3).
- For theory-based courses, the most important dimension is learning performance (C3); the other important dimensions are individual learning (C1) and group sharing (C2).

5.1.2 Discussion of the weights of criteria

We adopted the AHP approach to design the questionnaire and obtained the order of every criterion's weight in the process of estimating the iCan learning platform. From the result of each evaluation criterion of technology courses, information use and independent learning are the two most important criteria. The results show that users expect to gain the ability to apply the knowledge learned from the platform, and to acquire that knowledge successfully by themselves. In addition, they think enhancing learning attitude, enriching the learning processes and improving the participation in team projects are not very important in technology courses. For management courses, knowledge sharing and learning support are the most important criteria. Users expect that they can share information and knowledge within the learning group in the platform, and gain the ability to apply the knowledge learned from the platform. In addition, they think obtaining a sense of achievement by resolving problems from the learning platform and improving participation in team projects are not very important criteria in management courses. For theory-based

Table 5. The Weight of Each Dimension of Three Courses for Evaluating the E-learning Platform

Dimensions	*Technology courses*	*Management courses*	*Theory courses*
C1 Individual learning	0.46(1)	0.35(2)	0.33(2)
C2 Group sharing	0.20(3)	0.36(1)	0.28(3)
C3 Learning performance	0.34(2)	0.29(3)	0.39(1)

Note. The numbers in ( ) mean the order of each course.

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courses, independently learning and information usage are the most important criteria. That is, users expect to increase efficiency because of the ease of finding the information from the platform and obtaining the ability to successfully acquire the knowledge of courses by themselves. In addition, users think exploring new issues, collaboration and knowledge sharing aren't very important criteria in theory-based courses. Interestingly, the ranking order of technique courses and theory-based courses is similar, which reveals that the richness of data and learning individually with the aid of the platform is important for both types of courses.

5.1.3 Discussion on the weight of dimensions

We also used the data collected to calculate the weight of the three dimensions of evaluating the effectiveness of the e-learning platform. For technology courses, the most important dimension is individual learning (C1); the next dimensions are learning performance (C3) and group sharing (C2). That is, students think obtaining the ability and learning by themselves from the iCan learning platform is the most important dimension in technology courses. For management courses, the most important dimension is group sharing (C2); the next most important are individual learning (C1) and learning performance (C3). In other words, they emphasize the knowledge or skill sharing in team work and expect that the learning contents and processes can be enriched by group sharing from the platform. For theory-based courses, the most important dimension is learning performance (C3); the least important dimension is group sharing (C2). In other words, users think knowledge creating, grade advancement or skill obtaining are the most important issues when they are learning the theory-based courses from the platform.

5.2 Ranking practices in the e-learning platform and analyzing the usage conditions

Herein, we combined the crisp rating of each dimension or criterion (i.e., perceptions of usage experiences) with the associated weight (i.e., perception of importance) to calculate the fuzzy score for ranking practices in e-learning platforms. The crisp rating is derived from the Fuzzy linguistic rating according to the COA method in Section 2.2.

Technology courses. Based on the previous results, information use (C_{12}) and independent learning (C_{11}) are the two most important criteria for technology courses. Figure 4 shows that the function of *downloading materials* supports these two criteria. Moreover, we found that the scores of the *chat room* and *learning index* functions were not high, which might be the case because students seldom use them in technology courses.

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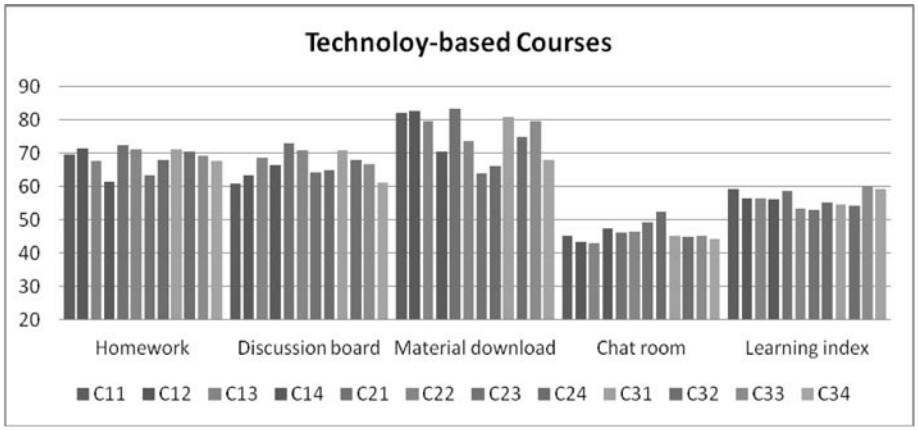


Figure 4. Combining Fuzzy Scores to Rank Functions of Technology-based Courses

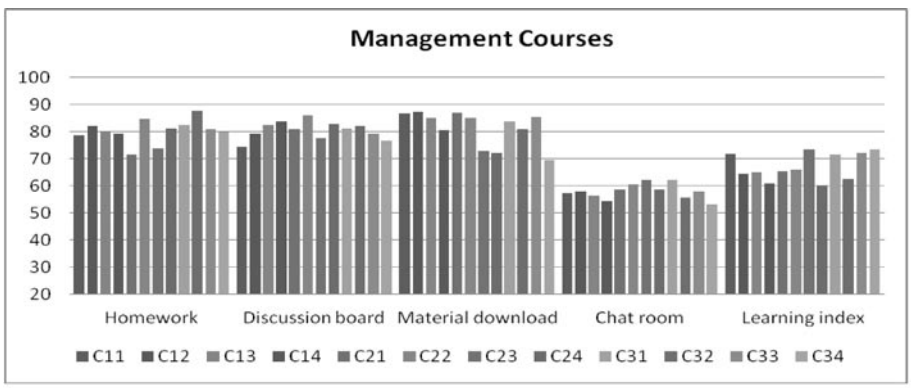


Figure 5. Combining Fuzzy Scores to Rank Functions of Management Courses

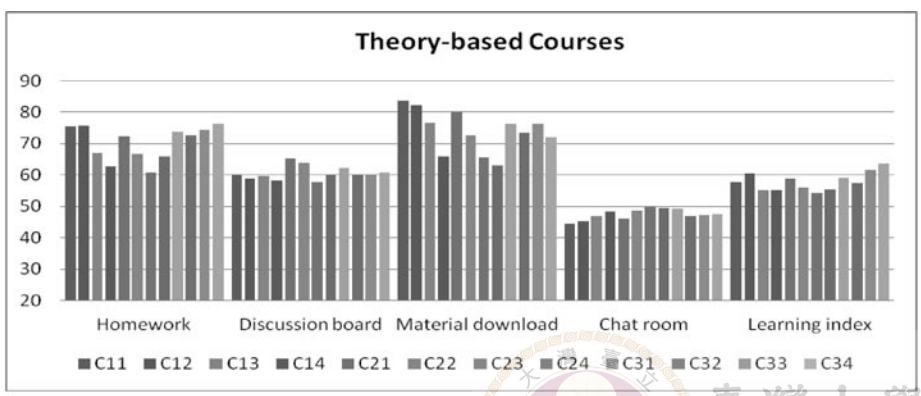


Figure 6. Combining Fuzzy Scores to Rank Functions of Theory-based Courses

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Management courses. Knowledge sharing (C_{22}) and learning support (C_{21}) are the two most important criteria for management courses. Figure 5 shows that the functions of *downloading materials* and *using discussion boards* support these two criteria. On average, downloading materials performed best in each category. Notably, we found that the score of the *chat room* function is lower than other functions. According to our preliminary observations, users seldom use the function; this may be due to its low quality.

Theory-based courses. Independently learning (C_{11}), and information usage (C_{12}) are the two most important criteria for theory-based courses. Figure 6 shows that the function of *downloading materials* supports these two criteria. Moreover, we found that the scores of the *chat room* and *learning index* functions were not high, which might be the case because students seldom use them in technology courses. The result is similar to the technology courses.

6. Overall Discussions and Implications

Similar to Section 5.2, we combined the crisp rating of each criterion or dimension (i.e. perception of usage experiences) with the associated weight (i.e. perception of importance) to calculate the fuzzy score of each criterion or dimension. The crisp rating is derived from the fuzzy linguistic rating according to the COA method in Section 2.2. That is, we can have a generic view from the perspective of relative importance between the criteria (or dimensions) and the actual users' using experiences in the iCan platform. Table 6 and Table 7 show the final score of each respective criterion and dimension. In addition, we analyze the relationship between the criteria and the performance of practices in the platform.

- For technology courses, the score of the criterion of information usage is the best. The next criteria are independently learning and efficiency. The top three ranking order is the same as the order of weights for technology courses as shown in Table 4. Based on the results, we suggest teachers who offer the technology courses utilize the benefits offered by the platform to provide more course-related material to support students to learn independently and efficiently. In Figure 3, we discovered the functions of "Material download" and "Homework" can support the criteria of information usage the most. Thus, teachers can also encourage students to use these functions for enhancing learning efficiency in technology courses.
- For management courses, the score of the criterion of knowledge sharing is the best. The next criteria are learning support and information usage. The top three ranking

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order is the same as the order of weights for management courses as shown in Table 4. Based on the results, we suggest teachers who offer the management courses stimulate students to share knowledge in the platform and then students can obtain support to learn subject knowledge. In Figure 4, we discovered the functioins of "Homework" and "Discussion board" can support the criteria of knowledge sharing the most. Thus, we suggest that teachers encourage students to use these functions for enhancing learning effectiveness of management courses.

- For theory-based courses, the score of the criterion of efficiency is the best. The next criteria are independently learning and information usage. Notably, efficiency is not in the top three of the ranking of weights for theory-based courses as shown in Table 4. The criterion of finding the answers to questions is ranked 7th for final scores of each criterion; however, it is one of the top three criteria for weights of each criterion as shown in Tables 4 and 6, respectively. The results indicate that the users' perceptions of importance of each criterion are not the same as the real usage experiences in the platform for theory-based courses. There should be some improvement based on the observations results.

Table 6. The Final Score of Each Criterion of Three Courses for Evaluating the E-learning Platform

Criteria	*Technology courses*	*Management courses*	*Theory-based courses*
C_{11} Independently learning	45.57(2)	32.40(7)	**40.20(2)**
C_{12} Information usage	45.96(1)	**40.76(3)**	**30.03(3)**
C_{13} Finding the answers of questions	36.22(4)	33.50(5)	25.06(7)
C_{14} Exploring new issue	16.59(9)	22.58(9)	10.46(12)
C_{21} Learning support	28.01(5)	**41.08(2)**	29.99(4)
C_{22} Knowledge sharing	16.06(10)	**46.21(1)**	25.25(6)
C_{23} Enhancing learning attitude	8.51(12)	16.19(12)	12.57(11)
C_{24} Collaboration	11.64(11)	28.39(8)	17.62(10)
C_{31} Efficiency	**40.58(3)**	37.31(4)	**49.04(1)**
C_{32} Learning achievement	21.22(7)	32.84(6)	25.77(5)
C_{33} Completeness of learning process	24.66(6)	19.52(10)	24.82(8)
C_{34} Sense of accomplishment	20.43(8)	17.64(11)	22.63(9)

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Table 7. The Final Score of Each Dimension of Three Courses for Evaluating the E-learning Platform

	Technology courses	*Management courses*	*Theory-based courses*
C1 Individual learning	63.58(1)	73.45(2)	73.75(2)
C2 Group sharing	62.89(3)	73.31(3)	73.33(3)
C3 Learning performance	63.07(2)	74.40(1)	75.29(1)

Herein, we analyze the relationship between the dimensions and the performance of practices in the platform as shown in Table 7. For technology courses, the dimension of *Individual learning* gets the highest score which means the iCan learning platform can support the dimension of *Individual learning* for technology courses the most. For management courses, the dimension of *learning performance* gets the highest score which means the iCan learning platform supports the dimension of learning performance for management courses the most. Table 7 also shows that the iCan learning platform can't support the dimension of *group sharing* very well; however, students pointed out the most important dimension is group sharing as shown in Table 5. For theory-based courses, the dimension of *learning performance* gets the highest score which means the iCan learning platform can support the dimension of l*earning performance* for theory-based courses the most. The ranking of scores for technology courses and theory-based courses is the same as the weights of importance given by students.

7. Conclusion and Future Work

In this research, we aimed to investigate the strengths and weaknesses of different kinds of practices offered in an e-learning platform. In this research, our evaluative learning platform is the iCan e-learning platform, which was adopted and has been widely used in Fu-Jen Catholic University. Therefore, we used the Analytic Hierarchy Process (AHP), a well-known multi-criteria evaluation approach, to evaluate users' perceptions after they used the learning platform. We aimed at three kinds of courses to estimate the e-learning platform—technology, management and theory-based courses. The model of this research considers functioning and objectivity in terms of the following three dimensions of learning effectiveness: *individual learning*, *group sharing* and *learning performance*. Twelve criteria with twelve evaluation items are used to investigate the effectiveness of the five functions. We linked knowledge management activities to the functions offered in e-learning

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to point out our deeper implications from these empirical investigation results.

Teachers can use the research results to achieve a course's goal based on the students' perceptions. We have several interesting findings and their implications from the survey results. Basically, different types of courses need different kinds of functions (practices) to achieve the goals of the course. For example, for theory-based courses, *learning performance* is the most important dimension, and *group sharing* is the most important dimension for management-based courses. In addition, our preliminary results show that the iCan platform cannot satisfy the needs of the type of management course. Furthermore, students think *information usage* is very important in technology courses. Thus, teachers should refer to the results to refine the courses and to help students achieve the object of information usage much more easily by using the e-learning platform. We expect that our empirical evaluation results will provide teachers with suggestions and guidelines for using the e-learning platform effectively to facilitate their teaching activities, and promote students' learning efficiency and satisfaction. In the future, the questionnaires should be refined by analyzing the relationship between dimensions and criteria by the Analytic Network Process (ANP). We also used an auxiliary questionnaire to understand the learners' perceptions of the e-learning platform after using it. In addition, we expect to extend the types of courses to understand of the effectiveness of the practices in the e-learning platform for supporting different kinds of courses. We should acknowledge that each function in the e-learning platform supports different knowledge management practices based on our preliminary results. For example, the *chat room* may support knowledge sharing, *the discussion board* may support the activities of communities of practices and *download materials* may support knowledge reuse (Brown & Duguid, 1998; Gray, 2001). That is, we use two terms, practices and functions, interchangeably in this work. In the future, we would like to explore the relationship between functions provided in the platform and the KM practices.

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由知識管理觀點評估E-learning教學平台成效：層級分析法

Evaluating the E-Learning Platform from the Perspective of Knowledge Management: The AHP Approach

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摘　要

各式的線上學習平台在過去十年間相繼以同步或是非同步的形式出現，其目的為協助學生改善學習的效率及提昇學習滿意度。不同於傳統面對面的教學模式，線上教學平台提供教師可以在任何時間或是任何地點與學生們進行討論及溝通；此外，可提昇教材充份的被重複利用的機會。為瞭解學生是否充份使用學習平台的資源並且瞭解其實際的學習成效，本研究選擇在輔仁大學校內被廣泛使用的教學平台－iCan，作為本研究調查對象。研究方法上使用知名與成熟的多目標決策分析方法－層級分析法（Analytic Hierarchy Process, AHP）以評估教學平台與相關功能的成效。研究首先採用腦力激盪法並基於學習者觀點設計層級分析法問卷，研究問卷架構考慮三項評估構面，其分別為個人學習（individual learning）、群組學習（group sharing）及學習成效（learning performance）。三個評估構面並分別包含四個評估項目與相關描述，最後透過這十二個項目評估教學平台中主要的五個功能，即所謂的實踐實務。研究並基於不同課程型態，透過層級分析法問卷以瞭解使用者預期線上學習平台提供的幫助，並進而分析線上學習平台各功能是否可支援不同課程型態之學習活動。研究預期透過該實證研究可以提供教師有效利用線上學習平台設計課程並提昇學生學習效率與滿意度。

關鍵字：層級分析法、數位學習平台、知識管理功能、使用者觀點

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