A Cross-Media Framework for Personalized Learning Systems

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Abstract—**Distance education is widely supported by Media technology, such as mail, telephone, TV programs, radio, email, and online forums. Growing up with media technology, distance education has a developing track of correspondence learning by radio, TV, online forums, and finally, arrives at personalized learning. Personalized learning relies on diverse media techniques. This paper introduces Cross-Media Strategy, a strategy for personalized learning. The Cross-Media Strategy is a concept assembled diverse media utilizing telephone, TV, radio, publishing, outdoor media, Internet, and many others. It largely enhances the current distance education techniques.**

Keywords-Cross-Media Strategy; distance education; personalized learning; software agent; recommender system; media guide agent.

I. INTRODUCTION

Distance education relies on media technology, which is developed from mail to publishes, from radio to TV, and finally, to Internet. Correspondence educations did not exist until learning via radio and TV programs became available. Nowadays, Electronic learning has again replaced radio and TV and become the mainstream in distance education. When an emerging technique takes place of the out-of-dates, evolution happens.

Helen Hasan has investigated the relations between tools, activity and knowledge management [1]. She considered cross-media as a primary psychological tool of learning and communication. A method with extensive support can strengthen the usability and stability of learning systems that employ it.

Cross-Media is a technique that utilizes multiple media techniques and then, reforms from their alterations [2]. Cross-Media courses have been provided in many famous universities, especially art and design courses [3]. *Transmedia Company* has produced a commercialized software product to facilitate multimedia designing and learning courseware development [4]. The Cross-Media strategy aims at providing a diversified solution for organizations to make effective business countermeasures in advertisement. For example, TOM.COM largely benefited from using Cross-Media strategy in its business operations [5].

Distance education holds similar properties to the advertisement industry. The common goal of them is to deliver information to people effectively and efficiently; they both base on media platforms. The difference is that advertisement is to sell products or services, whereas education is to transit knowledge. TOM.COM's success in advertisement using Cross-Media strategy also suggests a hypothesis of using Cross-Media strategy to facilitate distance education. The hypothesis has been side-supported by Kristóf Nyíri [7], who pointed out that Media Learning would eventually replace Electronic Learning. Wireless network performs weakly when supporting Media learning. Cross-Media strategy supporting, containing wireless networks, is more robust than other supporting techniques.

However, no mathematics model has been proposed to analyze Cross-Media and more research of supporting distance education needs to be done. Because of Cross-Media supporting, every part of a mobile learning system should provide more convenient ways for users to enter and utilize the system. Normally Cross-Media includes Radio, TV, Internet, wireless network, publishing, outdoor media, multimedia and so on. Contrast to correspondence education, learning via radio, TV, and E-learning still lacks a mathematics model. To the best of our knowledge, this paper is the first attempt of building up a mathematics model for Cross-Media strategy and defining Cross-Media as the supporting technology of mobile learning.

The basic idea and method of Cross-Media strategy can be described as a decision method incorporating multi-index analysis and multi-attribute usefulness review, which can be used not only in enterprise management but also in educational design and mobile learning. This kind of combination of different teaching methods means to select various learning media and to make better use of these media according to the teaching aim and content. The practice in Yunnan radio and TV University has indicated that the traditional teaching design method and teaching manner can be renewed and reformed with the support of IT. In this way, learning efficiency can be greatly improved. Moreover, in the life-long education system of a learning society, the education quality in distance education area can be guaranteed as well.

II. CROSS-MEDIA STRATEGY

In the digital era, information industry appears as a new creative industry which combines media with high-tech across different industries, such as Cross-Media industry and telecom industry, etc. The essential aim of Internet advertisement or

advertisement published by other media is to make the industry information about providers and details of products available to a large number of customers. Generally, this aim can be achieved by taking advantages of different media. In this way, the basis of customers (the developing space of the market) can be broadened and the potential needs of customers can be changed into the business revenue, even into profits. The main reason why enterprises practice Cross-Media strategy is to reduce the high risk of single medium business. To make full use of different kinds of media resources, enterprises can reduce the risk of losing their market and thus, significantly increase the possibility of making more profits. The usefulness of different media is shown in Fig.1. Through the analysis of philosophy ideal and decision theory, the so-called Cross-Media strategy is to find out the optimum solution which can best balance total usefulness and total cost of Cross-Media. The optimum solution can then guide enterprises to optimize the combinations of various media. Furthermore, the optimum solution can also help enterprises to make business decisions so as to maximize profits produced by Cross-Media. Similarly, in distance education area, according to the simulation and reaction theory of Vygostskian, Cross-Media, which is the primary psychological tool, should support knowledge management and distance learning effectively and efficiently. Learners can benefit much more from Cross-Media and its strategy.
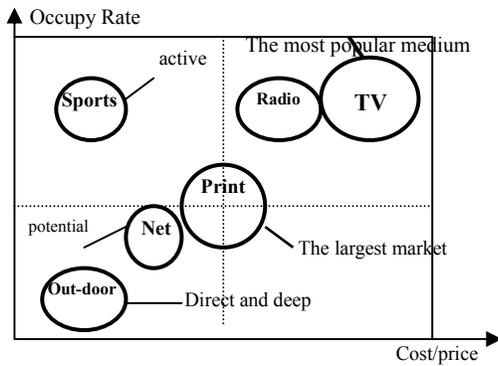
Suppose the total usefulness function of Cross-Media strategy is $u(m)$, and $u(m) = u(m_1, m_2, \cdots, m_n)$. Here, $u(m_1)$, $u(m_2), \cdots, u(m_n)$ are Single-media usefulness functions and n is the total number of these functions. Also, $u(m_i)$, $i = 1, 2, \cdots n$ is already known. The number of single-media attributes (such as cost, occupied rate of market, etc.) is p and each of them is denoted as $g_j = g_j(x); j = 1, 2, \cdots p$.

An attribute partiality is independent of other attributes and the usefulness of attribute g_j.

Therefore, $u(m_i) = \sum_{j=1}^{p} k_j u_j(g_j) = \sum_{j=1}^{p} k_j c_j g_j$, and

$$u(m) = \sum_{i=}^{n} u(m_i)$$

Among them, each of $g_1, g_2, \cdots g_p$ is an attribute vector; each of $m_1, m_2, \cdots, m_n$ is a media vector; k_j is a standardization constant (weighed value), and $\sum_{j=1}^{p} k_j = 1$.
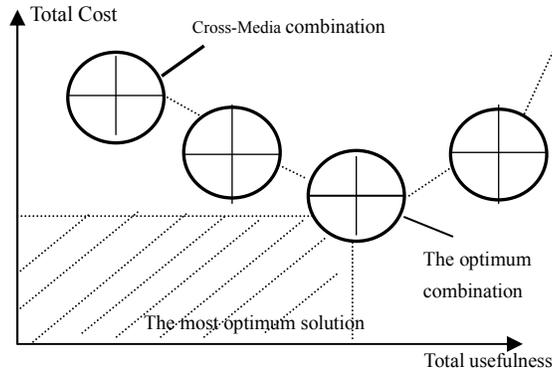

Figure 1. Single Medium

Figure 2. Usefulness-Total Cost

A. Mathematics Model

According to optimized curve of total cost-total usefulness of Cross-Media strategy (see Fig.2), Cross-Media strategy belongs to an evaluation/a decision method that is a quantifiable multi-index and multi-attribute usefulness analysis. Multi-attribute usefulness function (MAUF) can be used to solve the problem of definite decision with multi-object, continuous or separated decision object.

Cross-Media strategy with MAUF method can be used to perform quantitative analysis. Its mathematics model can be described in the following:

$u_j(g_j)$ is a usefulness function. The scope of its value is all real numbers from 0 to 1, i.e. $u_{max} = 1$, $u_{min} = 0$. Hence, if there are k media to be combined by Cross-Media strategy, by comparing the values of total usefulness function, we can determine the optimum solution of Cross-Media strategy, i.e. $u^*(m_k)$.

$$u^*(m_k) = \max\left\{\sum_{i=1}^{k} u(m_i), k = 1, 2, \cdots n\right\}$$

B. Application Effect

TOM.COM went on the market of Hong Kong United Exchange (code name 8001) in March 2000. Its business covers Mainland China, Hong Kong and Taiwan. TOM.COM is also a pioneer to practice Cross-Media strategy. It has established a strong media industry in the past few years, and is applying this strategy to other fields, such as out-door media, publishing media, Internet media and sports popularity, etc. Meanwhile, TOM.COM is actively expanding its supplementary service business in telecom area, aiming at the most competitive enterprise of media and Internet-telecom in China. TOM.COM has greatly increased business in Web-business and Cross-Media business after its success in practicing Cross-Media strategy (qualitative analysis). With a sharp increase (up about 145%) of Internet business, Cross-Media industry is also rocketing (up about 155%) at the same time. Even dating back to 2001, the total revenue of the company was already up to 6-fold.

III. MULTIMEDIA COMBINING TEACHING

A. Essential method

Table 1 qualitatively indicates the basic usefulness of a single teaching medium.

The media-combining teaching designing method is indicated with programming block (see Fig.3). The quantitative analysis about the optimum teaching plan can be performed if necessary.

B. Successful application

Through the practice of two courses in Yunnan Radio and Television University, multi-mediums' combining teaching and mobile learning method has proved to be successful. Table 2 shows the detail combination forms and uses in the courses in College of Mathematics and Engineering Drawing. Practice has indicated that the students' examination pass rate was raised about 15% and the teaching time was reduced by up to 50% of the traditional teaching time.

Usefulness Media	Cost	Function	Interactivity	Main usage
Text	Low	Abstract, convenient	Non-interactive	Read and personalized learning
Video	Lower	Vivid, require equipment	Non-interactive	learning guide
Video-CD	Lower	Vivid, popular, require equipment	Non-interactive	learning guide
CAI courseware	High	Vivid, high quality, require equipment	Interactive	Demonstration, experiment, test, examination
Teaching form	Lower	Vivid, face to face, easy to understand	Interactive	Class teaching
Internet	Average	Convenient information exchange	Interactive	Homework, answer, instruction
Internet+Mobile communication[6]	high	Convenient information exchange	Interactive	All step of learning and teaching

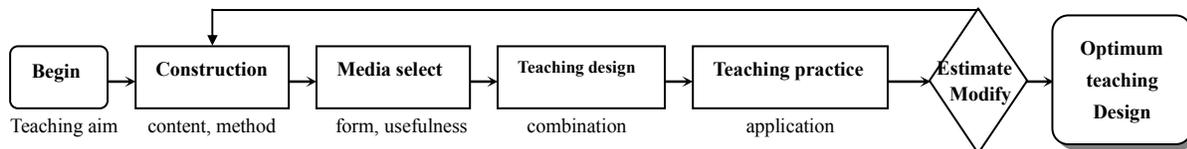TABLE 1. USEFULNESS OF A SINGLE TEACHING MEDIUM

Figure 3. Block of Multimedia Combination Teaching Design

TABLE 2. TYPICAL COURSE'S MEDIA COMBINATION FORMS AND USAGE [9]

Course	Teaching content	Media's selection	Teaching manner
College Math.	Basic principal, foundation	Text	Main textbook, class teaching
	Basic method	Video/VCD	Home video /audio/VCD equipment
	Teaching feedback	Email, network	Campus network/Internet wireless network
	Face to face instruction	Multi-media SMS	Multi-media classroom/multi-media computer/PDA
Engineering Drawing	Projection and space relationship	Teaching model/CAI	Special model /CAI/ Multi-media classroom
	Method to solving problem	Video/VCD	Home video /audio/VCD equipment
	Drawing standard	Text/VCD/network	Main textbook, face-to-face teaching/Internet
	Engineering drawing	CAI/drawing software	Multi-media classroom/multi-media computer
	Review instruction	Video/VCD	Home video /audio/VCD equipment

IV. MEDIA GUIDE AGENT SUPPORTED PERSONALIZED LEARNING

Some researchers argue that M learning would replace E learning in the future [7]. In their theories the supporting platform is wireless network [8]. Even though wireless network and mobile communication can support distance education [6, 8] and advertisement [5], it seems rather simple and actually is quite inefficient. Aiming at improving the efficiency, we established a BLOG based personalized learning platform, and utilized the platform to the courses of information management systems, turf science, electrical engineering, and advanced mathematics [10]. On the platform, teachers and learners have their own BLOGs; their actions were recorded in the system and classified into their courses; user experience was stored and presented on the system repository so that other users can share. As the feedback from users the platform was efficient in learning and teaching.

In this paper we propose a new concept named "media guide agent" to realize the Cross-Media strategy. The "media guide agent" is an intelligent agent which customizes right media, right services and learning materials to all the users of the system. Based on the above analysis and the real-world experience gained from the courses employed BLOG for teaching and learning, we design a framework of media guide agent supported personalized learning system. It is shown in Fig.4.

In Fig.4, the media library is the center of this system. Video, text, or graphic courseware will be conversed and transferred to the library. Any users in the system may have two or more ways to access the system. The Media Guide Agent also organizes personalized learning materials in the library and sends them in a personalized way to the related

users. The agent can evaluate the feedbacks from the users and prepare for the next action of 'send'.

V. CONCLUSIONS

Cross-Media strategy creates an essential way to optimize comprehensive benefits for enterprises using Internet and advertisement cooperation. It is an innovative enterprise management method and an effective business decision method as well. Its mathematics model, which is built up in this paper, is significant and necessary for both quantitative analysis and qualitative analysis.

This kind of resource-optimization strategy can be used to improve the teaching design method by combining various teaching media resources like texts, audio, video, video-CD, CAI courseware, teaching model and so on. This can give full play to their unique effect and comprehensive benefits.

To the best of our knowledge, this paper is the first attempt to forward the model of media guide agent supported personalized learning. We specified the mathematics model and the supporting system in this paper. Further research on it could be done in future and we plan to implement the system and test the effectiveness of the proposed model in real situations.

In the years ahead, it would be very important for people in the education of digital era to make full use of the innovative method and to improve the teaching and learning process. It is expected that the media guide agent supported personalized teaching and learning would become a significant management method, as well an effective teaching and learning method.
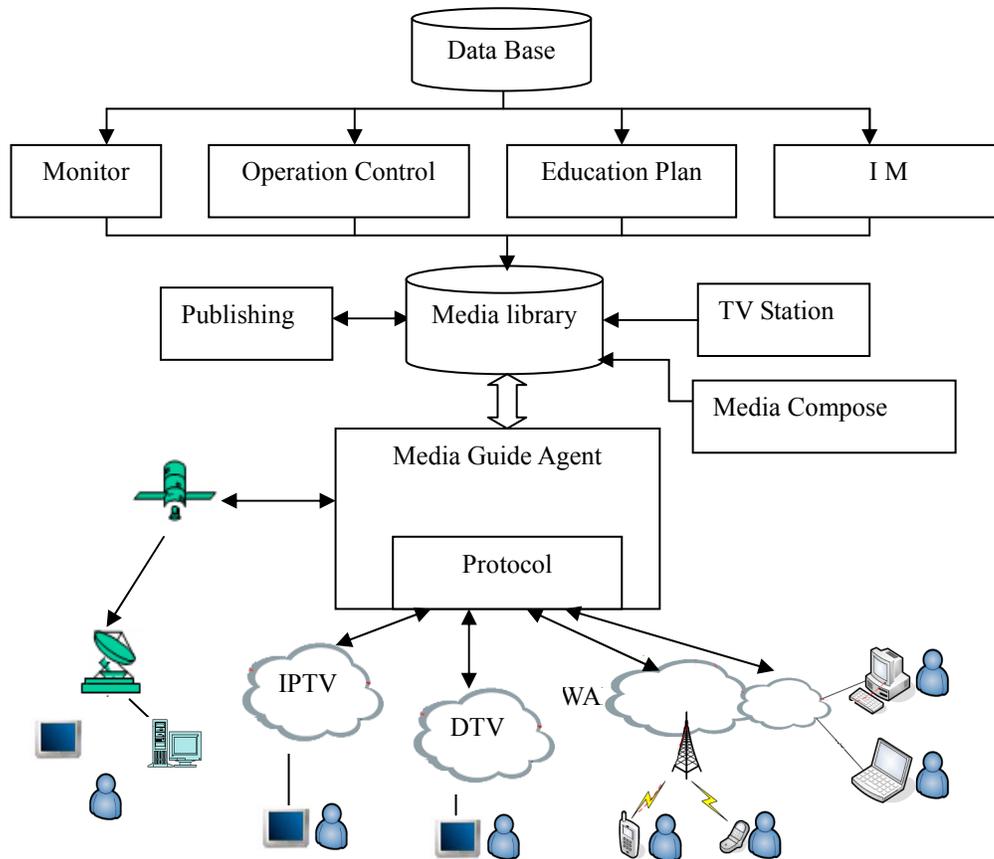
Figure 4. The Framework of Media Guide Agent Supported Personalized Learning System

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