A Roadmap of System Environment to Ubiquitous Learning and Its Application Patterns

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***Abstract*—This paper presents a roadmap of system environment to Ubiquitous Learning in the field of its application and research area, which is based on the analysis of the theory and practice research. The roadmap is called "The Roadmap of System Environment to Ubiquitous Learning", which is a mode includes three levels and six elements. Then, the paper concludes four typical application patterns of the roadmap. The U-Learning research and practice projects in recent years are sorted on the basis of the four application modes and the purpose is to seek the inner link among them in the roadmap. At last, the paper predicts the development tendency of system environment to Ubiquitous Learning and its roadmap so to promote the research and practice of the U-Learning area.**

Keywords-Ubiquitous Learning; System Environment; Application Mode; Roadmap

I. INTRODUCTION

Nowadays, the research of ubiquitous learning is mature [1]. It accumulated many research results which are from theory to resources, from terminal to platform, from activity to practice. And researchers form a consensus on the Ubiquitous Learning [2], which develops from E-learning to U-Learning. However, there is a one-sided and fuzzy state about ubiquitous learning research. Because we can't clearly grasp its overall systematic framework, sort specific application modes and forecast the long-term trend of U-Learning's development. The research constructs an application and research framework of U-Learning system environment, which is based on the projects of middle schools, teacher education institutes, education companies and combined with domestic and foreign U-Learning research and practice cases in recent years. This application and research framework is named as "The Roadmap of System Environment to Ubiquitous Learning", which will play an enlightening role on different levels of researches and practices.

Since University of California–Berkeley interactive laboratory launches the "Mobile Education" Project, the research and practice of U-Learning receives great attention. The large research Projects are European Union "from E-Learning to M-Learning", Europe "MOBILearn Project" and England Learning skills development office "U-Learning". The three Projects conducted macroscopic research. The research carried out by University of Birmingham, Stanford University and commercial corporations such as Ericsson, Nokia etc. pays attention to interactive techniques, learning model, the interdisciplinary approach with traditional classroom teaching of U-Learning, who conducted the research from a microscopic detail level.

The papers titled "The Introduction to The Mobile Distance Education" and "from distance learning to E-learning to M-Learning" translated by professor Ding Xingfu was published by the open education research magazine in 2000, which attracts U-Learning researchers. Ministry of Department of Higher Education made a notice of Project approval on the theory and practice research of Mobile Education in December, 2001. After that, more and more education institutes and incorporations took part in the research and practice of U-Learning [3].

II. RELATED WORKS

Recently, education departments and enterprises have done a lot about ubiquitous learning research. Among these, typical researches include European MOBILearn Project, From E-Learning to M-Learning and next generation learning: M-Learning, England M-Learning solution education social problems project, MIT STEP hand-held augment reality simulation game project and so on. Table 1 shows some typical practice and research projects or cases of U-Learning in recent years.

TABLE I. TYPICAL U-LEARNING RESEARCH CASES

Service object																					
	public audiences	Government																34	33		
		Society group							11	18	24	38						35	19		
		Youth group	5	36	39				1	4								4	39		
		Working staff							7	41								32	30	3	
		Children group							8	10											
	students	College students			37	29	30	26	23	2	6	9	13	14	16	17	38	28	33	22	
		Middle school students							12	15	21	27						29	33	31	
		Pupils							20	25	40									31	
Main driving force			Government		School education institutions													Companies			

Remark Serial number stands for: 1: European U-Learning 2: From E-Learning to U-Learning 3: U-Learning projects carried by Ericsson and other commercial companies 4: England Polytechnic University Ultralab U-Learning solution education social problems project 5: England learning and skills development project LSDA 6: England Lancaster University Ubiquitous Learning through using mobile phone with camera 7: Birmingham University of England research project 8: Savannah 9: U-Learning mode developed by SLL at Stanford University 10: MIT OLPC Project 11: American

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electronic visiting guideline 12: U-Learning research by Cohoes middle school in N.Y. 13: the Harvard graduate school of education HDUL Project 14: American Purdue University BoilerCast Website 15: Singapore MobiSkoolz System 16: Tokushima University BSUL Learning Environment 17:LOCH-informal learning supported by outdoor handheld mobile equipments 18: JAMIOLAS words learning using sensors 19: Japan Pocket Eijiro 20: Tokyo university Collaborative Learning System using PDA in the museum 21: Norway collaborative learning projects in museum environment 22: The university of Oslo KNOWMOBILE Project 23: Sweden Vaxjo University C-Notes 24: Taiwan Visiting navigation system for U-Learning visitors 25: Taiwan National Central University learning system for butterfly observation 26: Uniwap U-Learning Project 27: Portable Network Learning System 28: Multimedia mobile teaching network system developed by nanjing university and Japan panasonic communications industry company and SCC company 29: Ministry of education "U-Learning" Project 30: Nokia Mobiledu 31: Nokia Palm thinking English 32: EDU mobile English classes 33: Mobile school of Guangdong zengcheng area 34: Heyuan Ubiquitous Learning Platform 35: Ubiquitous Learning and information service platform for farmers in Gansu Province 36: China mobile Nongxintong 37: Mobile campus of Shanghai Television University 38: Mobile phone U-Learning curriculum designed by National Tsing Hua University 39: the theory and practice of Mobile education 40: North Carolina Mobile teaching experiment project 41: Mobile video course commenting platform of Capital Normal University

Table 1 analyzes the typical cases of U-Learning from two dimensions: research organization and service object. It shows that researches organized by governments are mainly to serve the public audience, which belong to public service. Studies organized by education institutions held very large proportion, whose main service objects are college students. The research plans carried out by companies and enterprises covered all kinds of learners. Enterprises and educational institutions are main driving forces in current development stage of U-Learning. But their target users are relatively independent.

III. THE ROADMAP OF SYSTEM ENVIRONMENT TO UBIQUITOUS LEARNING

The Roadmap of System Environment to Ubiquitous Learning is divided into three levels: U-Learning device environment (DE), learning support environment (LE) and service environment (SE). Each level includes two elements. There are six elements for all.(1) U-Learning terminal device;(2) U-Learning network access;(3) U-Learning platform development;(4) U-Learning resources construction;(5) U-Learning content choice and design;(6) U-Learning activity design. They are shown in figure 1.

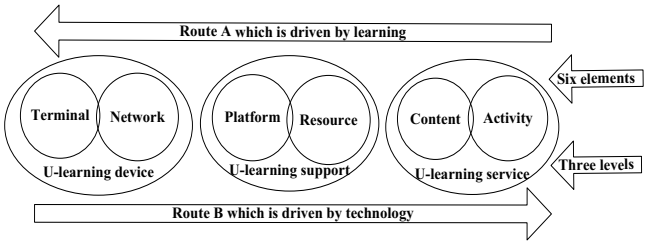

Figure 1. The Roadmap of System Environment to Ubiquitous Learning

We can see there are route A which is driven by learning and route B which is driven by technology drive six elements from different directions. U-Learning mostly is developing as the route B at present. It is determined by evolution process of U-Learning system environment, which is from terminal and network support to platform and resources support finally to content and activity support. The latter route B will gradually be replaced by the route A as the widespread popularity of U-Learning research and practice. There will be specialized mobile learning terminals by the drive of the route A. The six elements of the roadmap of system environment to Ubiquitous Learning are respectively described as follows:

U-Learning terminal devices include any general-purpose terminal equipment for learning. Popular U-learning devices at present are PDA, mobile phone, Smart Phone, Tablet PC, laptop, electronic dictionary, E-book, learning machine, MP3/MP4, iPod/iPad, Activote and so on. Some researches assess the quality of U-Learning terminal equipment from the following seven aspects: mobility of U-Learning terminal (portability and standby time of the equipment), access convenience, easy availability of resources, real-time communication, subsidiarity to learning, extensibility (the expansion of hardware and software) and practice cost.

U-Learning terminal can get all sorts of study resources by network to support learning. There mainly are three ways to connect to the network at present.1) Connections to the network by PCs through Data Cable or wireless (infrared, Blueteeth etc). 2) Connections to the network through mobile phone network (such as GPRS, GSM, CDMA). 3) Connections to wireless router within a certain region to the Internet.

The differences of the mobile terminal structure performance and PC resulted in the differences among mobile development platforms. The first thing to do is to analyze content to be developed [5] and then to choose appropriate application platform [6]. Pursuing practicability is the most remarkable characteristic of U-Learning resources [7]. The design of U-Learning resources should satisfy the real-time and practical learning needs [8]. That is to help students achieve practical learning purposes and solve the actual problems in daily life. The construction of Ubiquitous Learning resources mostly adopts the way of open mode. Users can participate in the construction of resources together [9]. Mostly learning contents are converted into various XML documents which mobile devices can identify and output. The size of learning resource is decided according to the size of mobile devices and network bandwidth [10].

The learning contents and learning time are fragmented, and learning equipments have limitations. So U-Learning contents shall meet the principles such as being scattered, simple and less input in the design process; In order to achieve a better teaching effect, teachers not only need choose proper learning contents but also design activities for U-Learning [11] to form a spanning spatio-temporal, continuous "seamless" learning experience [12] in formal learning.

Compared with the related research, the paper [13] divided U-Learning system into three generations according to the characteristics of the instructional mode. System function model designed in MOBILearn Project includes ten aspects such as mobile devices, user websites, content and so on. The roadmap of system environment of U-Learning conducts good integration to related research. Figure 2 shown is the integration of hierarchical relationships among the roadmap, three generations of U-Learning system environment and OMAF.

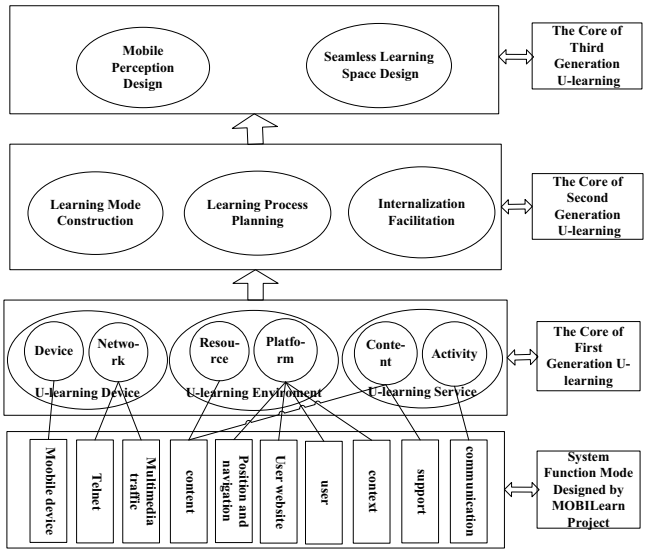

Figure 2. The integration of hierarchical relationships among the roadmap

IV. TYPICAL APPLICATION PATTERNS OF THE ROADMAP OF U-LEARNING SYSTEM ENVIRONMENT

The roadmap of system environment of ubiquitous learning includes three levels, device environment (DE), learning environment (LE) and service environment (SE). Learners are in the moving learning environment when they are learning the U-Learning course but they may not require the whole system environment. The typical application patterns of the roadmap can be summarized in the following four modes, DE+LE mode, DE+SE mode, DE+LE+SE mode and LE+SE mode.

DE+LE mode is a way of U-Learning which learners use mobile devices to learn the existing resources on the U-Learning platform. DE+SE mode is that learners use mobile devices and learn the knowledge in the activity designed by teachers. DE+LE+SE mode is that learners use mobile devices to learn the resources from the mobile device in the activity designed by teachers. LE+SE mode weakens the mobile learning equipment. Students can directly obtain the learning resources according to the design of the learning activity and obtain ubiquitous learning service. This mode emphasizes learners do not suffer terminal and network's restriction, which is based on seamless learning theory.

Table 2 shown is application patterns of typical U-Learning cases. It can conclude that common application patterns are DE+LE mode and DE+LE+SE mode. LE+SE mode is rarely used because of restrictions of devices' availability at anytime.

TABLE II. THE APPLICATION PATTERNS OF TYPICAL U-LEARNING CASE

Case Name	Application Mode	
Nokia "Mobiledu"	DE	LE
	Nokia phone+ mobile phone network	learning content+ learning software
Uniwap U-Learning Project	DE	LE
	WAP or Smartphone + mobile phone network	Instructional and learning resources
EDU mobile English classes	DE	LE
	mobile phone + mobile phone network	English learning resources + foreign language education online
Mobile education research developed by Nokia Company	DE	LE
	Nokia phone, computer+ WEB combined with WAP	"Mobile E-commerce" curriculum contents
U-Learning mode developed by SLL at Stanford University	DE	LE / SE
	laptop+ access through Wireless card	Foreign language learning modules + Learning System; test, teaching and interactive audio + practice, real-time communication
U-Learning projects carried by Ericsson and other commercial companies	DE	LE / SE
	Ericsson R380WAP phone+ mobile phone network	Curriculum "Application introduction of 3G"; 3G service, wap service +test, curriculum evaluation etc
U-Learning research by Cohoes middle school in N.Y.	DE	LE / SE
	handheld PC	Science teaching + Classroom Wizard Software; test, grade, real-time evaluation of test and analysis
Taiwan National Central University learning system for butterfly observation	DE	LE / SE
	PDA with camera	Identify butterfly categories + BWL System; outdoor observation + learning activities
Ubiquitous Learning System of JMU digital content international centre	DE	SE
	PDA+ wireless access	multimedia learning information + professional help through network

V. CONCLUSION AND FUTURE WORK

The technology trend of U-Learning is integrated, universal, portable and networking. Powerful computation and communication function will be merged into one hand-held network media device which is portable in the next five or ten years. Hand-held devices will change daily life through recording place, the weather, the character and knowledge around you and even thinking integrated situation perception function [13]. Mobile technologies have an effect on learning, making it migrated to the outside of

the classroom and entering the learner's real and virtual environment. Mobile technology will build rich connection among learning environment, learning resources and other learners.

According to the roadmap, the development of U-Learning will go through three stages, fundamental environment construction, system knowledge construction and learning service construction. Fundamental environment construction phase will gradually form theme resources learning environment and three levels of application environment, which is from region, organization to the whole nation in the network. This is the process of device environment (DE) construction and learning support environment (LE) in the roadmap. It will carry out large-scale knowledge system construction based on existing learning environment to perfect mobile environment in the systematic knowledge construction stage. It will also construct relevance among learning contents and the sharing and compliant of existing resources. This is the process of learning support environment (LE) construction and service environment (SE) construction. Learning service construction stage will be a new starting point of education socialization development.

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