A Cloud-based Ubiquitous Learning System Using Flow Learning Model – A Case Study of the Instruction on Nature and Life Sciences of Elementary School

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Abstract: In recent years, due to the rapid development of information technology and internet technology, and the use of cloud technology has become increasingly popular, learning through internet has turned into one of the most convenient and flexible channels for knowledge search and knowledge learning. Therefore, a cloud-based plant structure recognition ubiquitous learning system is designed in this research to implement the study on the adaptive learning model, and to discover the differences of the learning performances on the campus plants recognition between the learning through the proposed learning system and the learning through traditional outdoor learning, and furthermore to realize the satisfaction of the students on using the proposed learning system. In this study, there were 60 students of two classes (30 students each) randomly selected from four fifth-grade classes of an elementary school in Nantou County of Taiwan participated in the experiment. The students were evenly divided into experimental and control groups with 30 students in each group. Before the experimental instruction, a pre-test on understanding of campus plants were administered to the students of both experimental and control groups, and the outcomes of the pre-test were analyzed. The learning status information of individual student was stored in the learning portfolio database. Moreover, after the students log into the cloud-based adaptive ubiquitous learning system, when the student move to the front of the specific plant and using the RFID reader to scan the RFID tag, the handheld device will access the back-end system through wireless internet, and deliver the adaptive learning contents to the individual student according to their learning status obtained in the pre-test. After the experimental instruction, a post-test was administered to evaluate the learning performances of the students, and recommendations on the learning deficiencies were provided to individual student. Meanwhile, the outcomes of the post-test will be stored into the database as the reference for future adaptive instructions. The outcomes of the post-test reveal that the proposed cloud-based adaptive ubiquitous learning system can significantly improve the learning effectiveness of the students.

Keywords: Flow Learning, Cloud Computing, U-Learning, Context Awareness

Introduction

In recent years, the development of wireless network technology matures and the costs are gradually reduced, many ubiquitous learning (U-Learning) systems utilizing wireless internet have mushroomed all over learning area. Compared to E-Learning, U-Learning can do learning through handheld devices at anytime and anywhere, without time and space constraints (Hall & Bannon, 2006). In current nature and life sciences courses of elementary school, plants observation and understanding are the majority of the course contents. In the past, limited to time and space as well as the shortage of equipments, the instructions on plants observation and understanding can only be implemented by traditional textbook and photos. Therefore, a cloud-based plant structure recognition ubiquitous learning system is constructed in this study. The learning materials of plant structure classification are correspondently combined with the context on campus, and flow learning model is the fundamental of teaching to construct the context-aware plant structure category recognition system. The proposed system can allow the learners to learn in practical context and obtain adaptive learning materials. On the other hand, the learners are more impressed by the environment they are situated through personal experience and practical exercises, and the learners can achieve the best effects of contextual learning in appropriate situation.

1. Literature Review

1.1 Cloud Computing

Cloud computing concept is originally proposed by Google. In the initial stage, its application was only for the web information search. Later, when the demand of web search and the users greatly increased, it began to initiate the concept of computing data through the server host, and then the system compiled the results automatically and returned the outcomes to the user (Hayes, 2008). Therefore, cloud computing technology is not a new technology, in fact, it is the concept of a virtual space, and the specification of this concept is defined by the U.S. National Institute of Standards and Technology (NIST). The main operation of cloud computing is to integrate great scale of computing resources to develop a new internet interaction model, and the new internet interaction model also promotes the IT industry to provide variety of cloud service platforms (Aymerich, et al., 2008).

1.2 Flow Learning

Joseph Cornell is a famous American nature educator; he is good at leading the activities and games in outdoor education activities. He proposed five tenets of outdoor education activities, and they are: (1) Teach less, and share more. (2) Be receptive. (3) Focus the child's attention without delay. (4) Look and experience first; talk later. (5) A sense of joy should permeate the experience. Joseph Cornell developed Flow Learning, its main essence is individualized education, and arrange nature education activities depending on the situations of the students (Tanner, 1980). Flow Learning has four step-by-step stages (Simmons, 1998): (1) Stage 1: Awaken Enthusiasm (2) Stage 2: Focus Attention (3) Stage 3: Direct Experience (4) Stage 4: Share Inspiration. In this study, the four stages of Flow Learning Model are applied to design the learning activities, and furthermore are integrated into the cloud-based ubiquitous plant structure category recognition learning system.

1.3 U-Learning

Ubiquitous learning (U-Learning) provides the learners learning features and services according to the learner's learning context, taking into consideration of the people, events, time, manner, matter (Who, How, When, Where, and What), five learning situational parameters, it has become the most innovative and forward-looking E-Learning model and research issue(Dey, & Abowd, 1999).

Kwon (2004) proposed the so-called ubiquitous learning services through wireless communications, learners use mobile devices to conduct E-Learning, and due to the mobility and portability of the mobile devices, the learners can carry out the classrooms to outdoors without time and space constraints. Kwon (2004) also pointed out that the ubiquitous learning is the intersection of mobile technology and E-Learning, and thus it produces an anytime, anywhere learning experience, that is, through a personal digital assistant (PDA) or smart phone lightweight mobile devices to enjoy the learning process. Afterwards, Ma et al. (2005) further pointed out that the ubiquitous learning is the learners in aid of mobile devices, at any time and any place learning, and mobile devices are able to present the learning content to enhance the interaction between the learners and the learning context.

1.4 Context Awareness

Context-aware technology is the context provides users with the information or services related to the mission requirements, and context-aware is to deal with the information related to the interaction between users and application software, and the information is sufficient to describe entities such as people, events, time, manner, and material. In the study of Schilit & Theimer (1994), context-awareness is to deliver the appropriate information users need through the auxiliary mobile devices or sensors according to the user situated geographical information. The task of context-awareness is to respond to external changes of temporal and spatial environments, merge the environmental intelligence into the context of real life, and automatically update context information to fulfill the requirements of context-awareness for the users. Using wireless network to implement context-awareness can get rid of the spatial constraints, and when the users are not confined by location, it becomes easier to create ubiquitous learning environment. Context-awareness integrates environmental intelligence into the context of real life, it is expected to acquire and respond information through the integration of any computing devices and network technology at anytime, anywhere, and by any devices to reach ubiquitous realm. The main principle of context-awareness is to deliver users timely, relevant, and appropriate information (Ogata & Yano, 2004).

2. Research Methods

In this study, the objective is to construct a cloud-based ubiquitous learning environment in an elementary school in Nantou County of Taiwan. The learning environment is built to provide adaptive learning services to the learners according to the learning content of the "Plant" unit in "Nature and Life Sciences" elementary school course and the context of the experimental campus environment. ◦

2.1 Research Scenario

In this study, there were 60 students of two classes (30 students each) randomly selected from four fifth-grade classes of an elementary school in Nantou County of Taiwan participated in the experiment. The students were evenly divided into experimental and control groups with 30 students in each group. Before the experimental instruction, a pre-test on understanding of campus plants were administered to the students of both experimental and control groups. Moreover, the students of experimental group implemented the learning through cloud-based plant structure recognition ubiquitous learning system, and the students of control group implemented the learning through traditional outdoor learning.

2.2 Structure of the Proposed System

2.2.1 Cloud-based Ubiquitous Learning Service Framework

In this study, a cloud-based plant structure recognition ubiquitous learning system is constructed in an elementary school in Nantou County of Taiwan. Personalized ubiquitous learning services can be constructed in two stages; they are learning resource stage, and the stage of personalized learning services. They can be implemented in the following items:

- Learning Resource Planning: In this study, the objective is to allocate appropriate learning resources to the learners. Therefore, first of all, the data model descriptions of E-learning resources as well as learners have to be defined. In the learning resources, the plant structure learning resource classification ontology is proposed in this study to classify different types of learning resources.
- Adaptive Learning Activities: To allocate the nearest and the most accessible plant structure learning resources to the learner and generate personalized learning sheet according to the learner profile and the learning portfolio defined in the learner model, and the learner's individual learning situation.
- Intelligent Ubiquitous Learning Service Allocation: The learning contents are stored in cloud-based plant structure recognition ubiquitous learning system. The learner can use the integrated system of RFID, mobile devices, and wireless network to retrieve appropriate learning contents from the back-end of the system. Moreover, the RFID sensors are installed in different learning areas, and the learners need to visit all the learning areas of different plant structures for logging their learning portfolios.

2.2.2 Structure of Cloud-based Ubiquitous Learning System

In this study, the operating system of the proposed platform is Windows 2008 Server R2, and VMware VSphere and Tonido are utilized to construct the cloud-based ubiquitous learning platform. There are five components in the system: Learner Profile Database, Learning Module Database, Object-Oriented Plant Learning Material Database, Learning Portfolio Database, and Learning System Interface. The system diagram is shown in Figure 1.

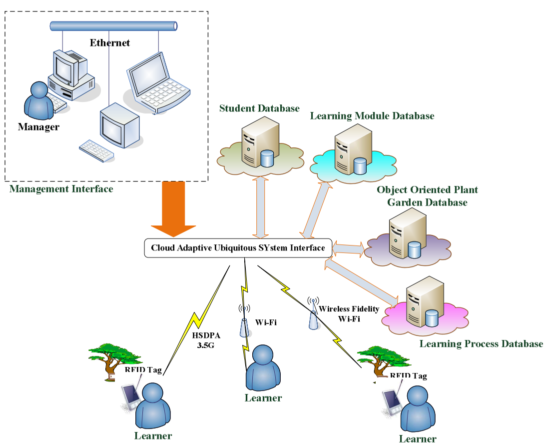

Figure 1. Cloud-based Ubiquitous Learning System Diagram

(1) Learner Profile Database: To record the profile of learner. For example: Class, ID, Name etc.
(2) Learning Module Database: To analyze the learning model of the learner, and provide appropriate information to the learner.
(3) Object-Oriented Plant Learning Material Database: To provide learning materials and test questions.
(4) Learning Portfolio Database: To store and manage the portfolios of the learners in order to analyze and track the learning performance of the learners, and improve the strategy of leaning activities.
(5) Learning System Interface: The human-computer interface between the mobile learning devices and the learners

2.3 Experiment Design

The experiment design process of this study includes the following seven steps:
(1) Grouping the learners adaptively according to their learning behaviors and learning portfolios.
(2) Giving the pretest on understanding the campus plants to the participated learners.
(3) Divide the learners into experimental and control groups according to their learning Types, and provide different learning activities to those two groups.
(4) The learners of the experimental group implement cloud-based ubiquitous learning through the combination of RFID system, PDA, and Wi-Fi wireless network, and the learners of the control group implement learning through traditional outdoor instruction.
(5) After the learning activities are completed, give post-test to the learners to realize the learning performance.
(6) Implement the learner satisfaction survey.
(7) Analyze the results of the learning performance post-test and satisfaction survey, and then do the adjustment on learning activities according to the analysis results.

2.4 Teaching Content Design

In this study, other than system implementation, the ubiquitous teaching activities were also designed. The teaching subject was nature and life sciences area of elementary school course, and the course material design and teaching content were mainly focused on the plants on the campus of the elementary school. There were 60 students of two classes (30 students each) randomly selected from four fifth-grade classes of an elementary school in Nantou County of Taiwan participated in the experiment. In the campus ecology learning, the flow learning strategy was adopted in the learning activities. The instruction process design of the course unit “The Bodies of Plants” is illustrated in Table 1.

Table 1: The Instruction Process Design of Ubiquitous Learning Environment

Learning Location：The Ecological Walk Path in an Elementary School			
Learning Area	Nature and Life Sciences	Grade	Fifth Grade
		Class Duration	160 minutes
Teaching Unit	The Body of Plant	Instructor	Teacher and System
Teaching Objective	1. We can find leave of plants in many places on campus through observation. 2. Through the leave puzzle game, we can find the leaf can be recognized by leaf shape, leaf edge, and leaf veins. 3. Through observation to know leaf shape, leaf edge, leaf veins, we can find the leaf shapes, leaf edges, leaf veins of different plants are not		

	certainly the same.
Teaching Activities with the Four Stages of Flow Learning	
Four Stages of Flow Learning	Design of Stage Activities
Awaken Enthusiasm	Using online colorful and pretty Flash game with the theme about plants to stimulate the students' interests of learning.
Focus Attention	Using mobile devices to play the instruction animations to know the styles and functions of leave, and how the existence of leave affects the environment.
Direct Experience	1. Go to the learning walk path to observe the shapes of leave and how they grow. 2. Take the test provided by the system.
Share Inspiration	Request the student to share their inspiration from learning and learning experiences through blog.

2.5 System Implementation

In this study, the four stages of flow learning were presented in the proposed cloud-based plant structure recognition learning system to achieve the learning performance on campus plant recognition. The user interface and screen shots of the system operations are illustrated and depicted as follows:

- The Stage of Awaken Enthusiasm: The identification of the learner is verified by the RFID system and then log into the system, and the system will present the colorful and pretty Flash game of plant structure to stimulate the learners'interests of learning, which is shown in Figure 2.
- The Stage of Focus Attention: The instructional videos, animations, and pictures are displayed through the mobile devices to introduce the structure of the plants. It can attract the attention of the learners, which is shown in Figure 3.
- The Stage of Direct Experience: The learning system will lead the learner to the designated location on campus, and the RFID reader on the handheld device will read the RFID tag, and the system will deliver adaptive learning contents to the learners for practical learning. The test of the learning contents will be given after the learning activities.
- The Stage of Share Inspiration: The learning system will analyze the learning outcomes, if the learners pass the test, the learners can get into the blog to share their learning experiences and inspiration. For instance, if the learners cannot pass the test, the system will provide remedial learning materials according to the diagnosed errors, and then repeats the cycle till the learners pass the test.

Figure 2. System Login Screen Shot

Figure 3. Instruction Screen Shot

3. Research Results and Performance Analysis

3.1 Learning Outcomes Analysis of Cloud-based Ubiquitous Instruction

In this study, the mean and standard deviation of learning performance pre-test and post-test are calculated, the paired t-test are implemented to exam whether the mean of pre-test and post-test reaches significant difference, which is illustrated in Table 2. Moreover, the independent sample t-test for the pre-test and the post-test of experimental and control groups are illustrated in Table 3.

Table 2: Analysis Results of Campus Plant Learning Outcome Test

	Variable Name	N	M	SD	t Value	p Value
Experimental Group	Pre-Test	30	55.85	16.21		
	Post-Test	30	80.59	12.24		
	(Pre-Test) (Post-Test)		-24.741	5.769	-22.286	.000
Control Group	Pre-Test	30	57.00	15.99		
	Post-Test	30	68.43	13.61		
	(Pre-Test) (Post-Test)		-11.429	5.189	-11.655	.000

In Table 2, the pre-test mean values of the experimental and control groups are 55.85 and 57.0 respectively, and the post-test mean values of the experimental and control groups are 80.59 and 68.43 respectively. After the cloud-based ubiquitous learning, the post-test mean value of experimental group is higher than the pre-test mean value of experimental group, and reach the significant level (t value= -22.286，p<.001). The control group post-test mean value is more than the control group pre-test mean value and reaches the significant level (t value = 11.655, p<.001). Moreover, the learning performance of experimental group is better than that of control group.

Table 3: Independent Sample t-test of Experimental and Control Groups

		Levene-Test		Independent-Sample t-test				
		F-Test	p Value	t	df	p Value (Two Tailed)	MD	SEM
Pre-Test	Equal Variances Assumed	.046	.830	.264	53	.792	1.148	4.342
	Not Assumed			.264	52.863	.793	1.148	4.343
Post-Test	Equal Variances Assumed	.028	.868	-3.481	53	.001	-12.164	3.495
	Not Assumed			-3.488	52.748	.001	-12.164	3.488

In Table 3, the F-Test value is 0.046 and two tailed test p value = 0.830>0.05, therefore there are no significant differences between two groups of variables. When t=0.264, the p value of two tailed test is p=0.792>0.05, the pre-tests of experimental and control group are no differences, which means no differences between those two groups in the very beginning. When the F-Test value of the post-test is 0.028, then the p value of two tailed test is p value=0.001<0.05, there are significant differences between two groups. It means the learning performance of the experimental group using the cloud-based ubiquitous learning system is better than that of the control group.

3.2 The Result Analysis for the Different Score Groups

In this study, the analysis results of campus plant learning outcome test for different score groups are illustrated in Table 4. In addition, the results of independent sample t-test for different score groups are illustrated in Table 5.

Table 4: Analysis Results of Campus Plant Learning Outcome Test for Different Score Groups

	Variable Name	N	M	SD	t value	p Value
Experimental Group – High-Score	(Pre-Test) (Post-Test)	9	-18.500	4.243	-12.333	.000
Experimental Group – Mid-Score	(Pre-Test) (Post-Test)	12	-26.182	3.737	-23.238	.000
Experimental Group – Low-Score	(Pre-Test) (Post-Test)	9	-29.000	4.140	-19.811	.000
Control Group - High-Score	(Pre-Test) (Post-Test)	9	-7.500	2.563	-8.275	.000
Control Group - Mid-Score	(Pre-Test) (Post-Test)	12	-12.333	5.774	-7.400	.000
Control Group - Low-Score	(Pre-Test) (Post-Test)	9	-14.000	4.276	-9.260	.000

Table 5: The Independent Sample t-test for Different Score Groups

		Levene-Test		Independent-Sample T Test				
		F-Test	p Value	t	df	p Value (Two Tailed)	MD	SEM
High-Score Pre-Test	Equal Variances Assumed	2.000	.179	.564	14	.582	2.000	3.546
	Not Assumed			.564	13.031	.582	2.000	3.546
Mid-Score Pre-Test	Equal Variances Assumed	.001	.973	-.182	21	.857	-.455	2.492
	Not Assumed			-.182	20.782	.857	-.455	2.494
Low-Score Pre-Test	Equal Variances Assumed	.380	.548	.816	14	.428	2.500	3.065
	Not Assumed			.816	13.875	.428	2.500	3.065
High-Score Post-Test	Equal Variances Assumed	11.948	.004	-3.610	14	.003	-9.000	2.493
	Not Assumed			-3.610	9.084	.006	-9.000	2.493
Mid-Score Post-Test	Equal Variances Assumed	.262	.614	-7.762	21	.000	-14.303	1.843
	Not Assumed			-7.634	17.469	.000	-14.303	1.874
Low-Score Post-Test	Equal Variances Assumed	3.916	.068	-3.216	14	.006	-12.500	3.887
	Not Assumed			-3.216	12.380	.007	-12.500	3.887

3.3 Satisfaction Survey Results

In this study, questionnaire with 15 questions are used to do the survey of satisfaction on the cloud-based campus plant structure recognition system, and more than 90% students are satisfied with the learning system. The teachers and experts are also satisfied with the operations of the proposed learning system.

4. Conclusion

In the traditional outdoor instruction, the students are easy to be distracted by many reasons, and then it will affect the learning performance. Therefore, a cloud-based ubiquitous learning system is developed to fulfill the needs of learning outdoor plant structure recognition; meanwhile, Flow Learning Model is applied into the proposed system. The nature and life sciences unit of elementary school is the main contents in the system. The final outcomes indicate that the learning performances of the students using the proposed system can significantly improve their learning performances. The results of this study also can be the reference for future research on outdoor educations.

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