The Ubiquitous Learning Evaluation Method Based on Meaningful Learning

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Abstract: There has been a dramatic growth of research concerned about the ubiquitous learning (u-learning) in recent years. It has an urgent need that U-learning systems have to be continuously evaluated and improved for ensuring the system reliability. However, there are only few or none of existent u-learning system evaluation researches. Therefore, this study develops a u-learning evaluation method supporting meaningful learning. According to the principles of meaningful learning and u-learning, the study blends the characters of them to form five dimensions and ten criteria based on which the evaluation method is developed. The evaluation method adopts both the statistics and the analytic hierarchy process (AHP) to check the degree of meaningful learning that includes overall and inner aspects. Initially, the statistics approach can be treated as entirety analysis to develop a scale of meaningful learning for u-learning which can present the overall degree of meaningful learning. Subsequently, the AHP method can be an inner inspection to collect learners' opinions after practicing learning activities and then the results could reveal the related importance of functions in u-learning. According to the overall and inner analysis, u-learning system developers and designers can realize the strength and weakness of the u-learning system. Consequently, existing u-learning systems can be reassessed by our evaluation method and u-learning system can be improved toward the meaningful learning according to the results of the evaluation method.

Keywords: Evaluation methodology, ubiquitous learning, meaningful learning

1. Introduction

Advances in ubiquitous computing and context-aware technologies have furnished instructors with the opportunity of engaging in novel educational processes. These novelties not only affect our life but also shift our ways of learning [7]. Nowadays, researches in terms of ubiquitous learning (u-learning) are also being stimulated by these changes. The u-learning environment provided an interoperable, pervasive, interactive, and seamless learning architecture to integrate, connect, and share learning resources among appropriate identities [6][8][11][12][14].

Last few years, the u-learning has been extensively investigated and applied to domain knowledge training, such as history, linguistic, nature science, and so on [1][4][11][12]. For reliability, these u-learning applications have to be re-evaluated and re-improved constantly by learners, instructors and domain experts. To this end, a systematic evaluation method is needed to evaluate these u-learning works. Since u-learning has its own unique characteristics, previous evaluation methodologies which were used to evaluate e-learning systems cannot be directly applied to evaluate it [3][10]. In order to objectively evaluate u-learning systems, this study is based on meaningful learning and introduces a systematic evaluation approach for u-learning environment.

Our evaluation method adopts both the statistics and the analytic hierarchy process (AHP) to check the degree of meaningful learning that includes overall and inner aspects.

Initially, the statistics approach can be treated as entirety analysis to develop a scale of meaningful learning for u-learning which can present the overall degree of meaningful learning. Subsequently, the AHP method can be an inner inspection to collect learners' opinions after practicing learning activities and then the results could reveal the related importance of functions in u-learning [3][13]. According to the overall and inner analysis, u-learning system developers and designers can realize the strength and weakness of the u-learning system. Consequently, existing u-learning systems can be reassessed by our evaluation method and u-learning system can be improved toward the meaningful learning according to the results of the evaluation method.

The remainder of this article is organized as follows. In Section 2, we survey the relevant literatures. Section 3 introduces our evaluation method. Subsequently, Section 4 shows the evaluation result, and finally, Section 5 sums up this study.

2. Literature Review

2.1 Ubiquitous Learning

This study surveyed existent researches of u-learning. In summary, the definitions and corresponding functions of the main characteristics of u-learning are described in Table 1 [1][2][8][11][12][14].

Table 1. The characteristics, functions of u-learning

Characteristics of u-learning	**Definition**	**Functions in u-learning**
Urgency of learning need	U-learning environments can be used for an urgent matter of learning.	● Keyword search ● Online problem diagnosis
Initiative of knowledge acquisition	U-learning systems can provide the information, which closes to learners' requests in time.	● Material presentation ● Study guidance
Interactivity of learning process	Learners can communicate with peers, teachers, and experts effectively through the interfaces of u-learning systems.	● Emails between instructors or learners ● Comments on the course, website, etc.
Situation of instructional activity	In the u-learning environment, the learning process can be embedded in daily life, as well as the knowledge requirements are presented in authentic context.	● Linking to related learning materials ● Learners' feedback to learning materials
Context-awareness	U-learning environments are context-awareness, which based on learners' statuses or the situations of the authentic environment to provide the related information to learners.	● RFID ● GPS ● Sensor ● Bio-feedback

Actively provides personalized services	Based on the context around learners, the u-learning systems would actively provide personalized supports to learners by the right way, in the right place, and at the right time.	● Individualized learning database ● User guidance
Self-regulated learning	U-learning systems would provide some functions to help learners that could actively control their learning progresses by themselves.	● Diary and reflective response ● Calendar ● Task-list
Seamless learning	U-learning environments enable seamless learning at anywhere and anytime. The learners are allowed to learn without being interrupted while moving from place to place.	● Internet ● Wireless networks ● Ad hoc networks
Adapt the subject contents	U-learning environments are able to adapt the subject contents to suit the capability of various learning devices.	● Multimedia presentation (text, graphics, animation, audio, etc.)
Learning community	U-learning environments help online community with bring field experience on the Internet to enrich the learning interaction between learners and teachers.	● Blog or forum ● Messenger ● Chat rooms

2.2 Meaningful Learning

In this study, the dimensions of meaningful learning are formulated for evaluating u-learning environments. According to Jonassen (1995) [9] and Grabe (2007) [5], the principle of meaningful learning has five dimensions defined in Table 2.

Table 2. The principle of meaningful learning

Dimensions	**Definition**
Active	Learners are organisms to interact with the environment, in which they processed their learning and monitor the leaning process. Therefore, the learners are dynamic roles in the learning activities.
Authentic	Learning in authentic environment stimulates learning motivation as learners accept learning tasks designed from the real world.
Constructive	Constructive learning means that learners accommodate new ideas to their prior knowledge/experiences.

Cooperative	Working in knowledge building community makes it possible for learners to exploit each other's skills and provide social support and modeling for other learners.
Integrated	Content knowledge and technology should be integrated to furnish teaching/learning process with smooth and vivid applications.

3. Evaluation Method for U-Learning

This study primarily involved a method based on meaningful learning for evaluating u-learning systems/environments. The evaluation method comprised of four stages concerning u-learning practice, entirety analysis, inner inspection, and system adjustment, as figure 1. The process of the evaluation method was accomplished step by step. Firstly, a learning activity that used the u-learning system is carried out. Secondly, participants of this u-learning activity are selected to complete the questionnaire scale based on meaningful learning to evaluate u-learning. And then, it could analyze the entirety by this scale. Therefore, we realized the u-learning' whole degree of meaningful learning. Next, from microscopic to microcosmic aspect, this study processed inner inspection that can further investigate functions or characteristics of u-learning. Finally, according to results of analysis, the u-learning system can be adjusted to enhance the quality of the u-learning environment by taking the right way to correct the shortcomings. It is followed by the statement about the evaluation method.

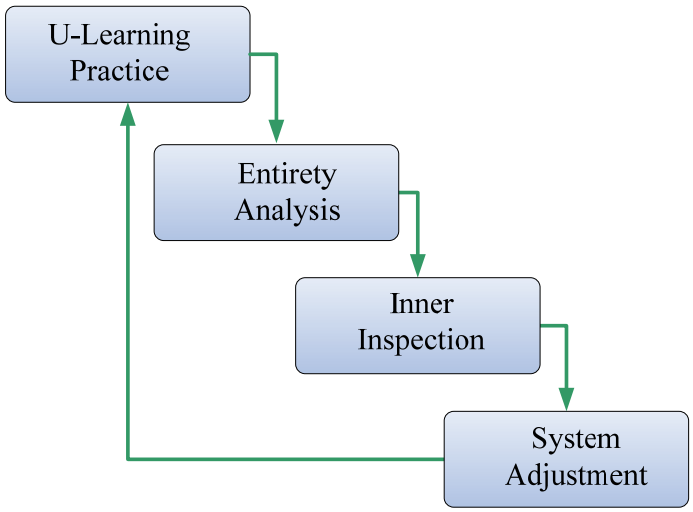

Figure 1. The Evaluation Method Framework

3.1 U-learning practice

U-learning practice means that new information technologies are used, such as ubiquitous computing, sensor network, context-aware technology etc., to implement the ubiquitous learning system which combines the instruction material for learning activities. In this case study, we implemented a ubiquitous tree observing activity which belongs to the domain of nature science. In the learning activity, learners can learn the knowledge of trees in the real situation easily without restrictions of time and space. The participants consisted of 61

fifth grade students of Tainan municipal Dong-Guang elementary school in Taiwan, and the investigation period lasted 2 months, Mar and June in 2007.

3.2 Entirety analysis

This study developed a questionnaire, which includes the dimensions of meaningful learning through the literature review, as the instrument of entirety analysis. There were five dimensions: *active, authentic, constructive, cooperative,* and *integrated* to construct the items of the questionnaire that adopted five Likert rating scale to rate the satisfaction of each variable (5 is "very satisfied," 4 is "satisfied" … and 1 is very dissatisfied). In addition, the authors set the mean 4 (satisfied) as the threshold score for evaluating the meaningful u-learning environment in the case study. If the mean of the entirety analysis is more than 4 points, it was considered that meaningful learning was achieved in the u-learning activity. In contrast, the result of the entirety analysis was less than 4 points, it was suggested the quality of the u-learning system has to be improved.

3.3 Inner inspection

The inner inspection of the evaluation method is constructed from the analysis of literature to build a hierarchical decision structure. The authors utilize the five dimensions in the principle of meaningful learning and then adopt the u-learning features as the criteria to embody the dimensions. The hierarchy decision structure is shown in Figure 2. Based on the structure, the AHP-based questionnaire survey can be developed by experts and teachers, and the questionnaire can then be utilized to collect learners' opinions. In addition, the critical/relative important criterion will be figure out through the AHP [3][13]. Finally, in this inner inspection, we can understand the strong or weak functions of the present u-learning environment.

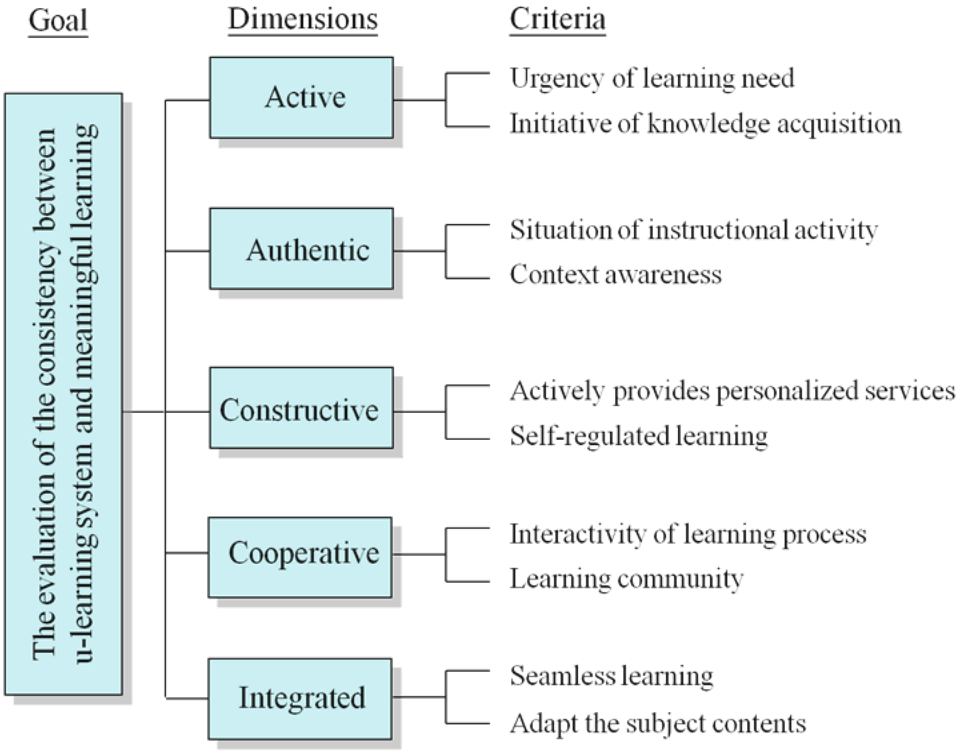

Figure 2. The hierarchy structure for evaluating u-learning [3]

3.4 System adjustment

This study adjusts the learning systems according to the results and findings of experiments provided by the entirety analysis and inner inspection. We can comprehend the whole situation of meaningful learning in u-leaning systems and tell which functions (as Table 1) are weak. The developers of u-learning systems could modify the weak functions and enhance the quality of u-learning systems. Consequently, learners can get acquisition through meaningful ubiquitous learning.

4. Results

The results of the evaluation are divided into two parts: results of entirety analysis, and results of inner inspection. Based on the evaluation method procedures, firstly we can realize the overall degree of meaningful learning in u-learning system. Consequently, the evaluation results of inner inspection can reveal the relative strength/weakness characteristics and functions of the u-learning systems. Further, according to the findings, developers and instructors would improve and adjust the u-learning activities.

4.1 Results of entirety analysis

The data for this study was gathered by a questionnaire survey. Some experts were invited to view and modify the items, which formed the expert validity. After that, the questionnaire has 16 items. Next, Subjects were asked to indicate their satisfaction toward the u-learning systems through the questionnaire. The Cronbach's Alpha reliability of the scale for the whole part was 0.86 which is moderate.

From Table 3, the three dimensions: *active, integrated* and *authentic* achieved the threshold value (Mean is about 4) which means the learners were satisfied at these three dimensions. In other words, the two dimensions: *cooperative* and *constructive* are merely considered insufficient by learners' opinion (Means is about 3). Total score of dimensions (Mean is about 3.7) are less than the threshold value. Therefore, the u-learning activities in the case study did not strictly conform the meaningful learning. Further, next section introduces the results of inner inspection which showed the detail inner relations of the u-learning system.

Table 3. The statics of the entirety analysis

#	Items	Mean	S. D.	Component factor load	Varimax factor load
Factor 1: Active		4.07			
1.	I can active process myself learning	4.09	0.75	0.49	0.64
2.	I would monitor my leaning process	4.01	0.62	0.63	0.69
3.	I am a dynamic roles in the learning activities	4.06	0.55	0.46	0.71
Factor 2: Cooperative		3.05			
4.	I am willing to share my experience with others	3.21	0.69	0.51	0.72
5.	I am willing to share my knowledge with others	3.13	0.67	0.66	0.81
6.	Other learners are willing to share their experience and knowledge with me	2.81	0.71	0.63	0.88
Factor 3: Integrated		4.03			

7.	The u-learning system has sufficient functions	4.03	0.52	0.60	0.79
8.	The u-learning system is stable and errors are not common	4.05	0.53	0.58	0.85
9.	The u-learning system would integrate technology and content knowledge	402	0.49	0.62	0.81
Factor 4: Authentic		4.13			
10.	I can directly observe the surrounding environment	4.23	0.70	0.58	0.76
11.	I am learning by doing in authentic environment	4.06	0.57	0.59	0.79
12.	The u-learning system provides a situation learning	4.21	0.62	0.58	0.69
13.	The u-learning system incorporates the realistic environment into our learning	4.02	0.76	0.69	0.86
Factor 5: Constructive		3.34			
14.	I can accommodate new ideas into my prior experience	3.29	0.66	0.58	0.82
15.	I can accommodate new ideas into my prior knowledge	3.28	0.69	0.68	0.85
16.	I understand what to learn in the learning activities	3.55	0.76	0.60	0.76

4.2 Results of inner inspection

The characteristics of u-learning which are least relative important are considered the defect in certain function of the u-learning environment. Table 4 shows that the *context-awareness* (overall weight=0.123) is the most important criterion, and the *learning community* (overall weight=0.061) is relatively unimportant. In addition, the overall weight of *Interactivity of learning process* (0.073) and *Urgency of learning need* (0.073) are too low. Therefore, the results imply that *learning community*, *Interactivity of learning process* and *Urgency of learning need* criteria in this case study should be improved toward the meaningful learning. For instance, in order to ameliorate *learning community* criteria, we can add or improve these corresponding functions: blog, forum, messenger, and chat rooms (refer to Table 1).

Table 4. Importance of criteria

#	Dimension	Criteria	Overall weight
1	Active	Urgency of learning need	0.073
2	Active	Initiative of knowledge acquisition	0.079
3	Authentic	Situation of instructional activity	0.121
4	Authentic	Context awareness	0.123
5	Constructive	Actively provides personalized	0.080
6	Constructive	Self-regulated learning	0.084
7	Cooperative	Interactivity of learning process	0.073
8	Cooperative	Learning community	0.061
9	Integrated	Seamless learning	0.112

10	Integrated	Adapt the subject contents	0.113

5. Conclusions

In recent years, u-learning has been a new trend in education. It has an urgent need that U-learning systems/environments have to be continuously evaluated and improved for ensuring reliability and quality of the system. Thus this study develops the u-learning evaluation method based on meaningful learning. The evaluation method adopts both the statistics and the analytic hierarchy process (AHP) to check the degree of meaningful learning that includes overall and inner aspects. Through the evaluation results, the system developers can realize the advantages and defects functions of the u-learning system from the view of the meaningful learning. Consequently, the developers can then pay their effort to amend the weakness or to remain the strength of present u-learning system to achieve the meaningful learning.

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