Adaptive Ecology M-learning for National Park Based on Scaffolding Theory

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***Abstract*—An adaptive ecology m-learning framework applied for national parks is proposed in this paper. The traditional ecology guiding service uses static web page or fixed placard to prompt and provide ecology information to learners. It can not provide adaptive learning anytime and anywhere. Learners can not obtain real-time ecology guiding information and have a good adaptive learning based on learners' knowledge background, and time and location. This study proposes a framework based on Scaffolding Theory that provide learners mobile, dynamic and adaptive ecology guiding service to national parks. Scaffolding Theory is to support learners a knowledge structure for systematic learning. Based on Scaffolding Theory, learners are identified by background (e.g. age and gender), knowledge (e.g. cognitive base, knowledge requirement and learning objective), and interests. Moreover, adaptive and appropriate ecology knowledge based on learners' properties is provided dynamically. Furthermore, learning steps and contents are able to be adjusted flexibly by learners' feedback. In addition, this study also adopt context awareness to provide the learner a suitable route planning for ecology guiding service according to environment factors such as weather condition, time and season, prediction of tide, UV rays and rain rate where learners located. Landscapes and ecology events such as Migratory birds in transit within the route can be actively delivered to learners immediately using interactive applications such as multimedia messages (e.g. text, image and video). Attention and enjoyment of learners can be increased and ecology education purpose of national parks can be achieved.**

Keywords: Context-aware computing, m-learning, Scaffolding Theory

I. Introduction

A "national park" is an area with a country's special features or cultural or historic significance. The first national park in the world was Yellowstone National Park, established in the US in 1872 and, since then, over 3,800 national parks have been established worldwide [1]. International Union for Conservation of Nature, IUCN, founded in 1948 as the world's first global environmental organization, today is the largest professional global conservation network and a leading authority on the environment and sustainable development. IUCN's mission is to help the world to find pragmatic solutions to our most pressing environment and development challenges [2]. The management of national park gradually escapes the way of "no people in national park" and hopes to find a harmony way between human and wild life. By sustainable interpretation and the ecology tourism with profound experience and respect to nature, visitors can observe and learn from nature and then the sustainable management of national park can be achieved [3-7]. Therefore, ecology education is an important function of national park management. Figuring out how to achieve the purpose of guiding service of national park through new technology assistant and then let more people enjoying, understanding and acting to improve, the natural environment, more often is the intention of this study.

Traditional ecology guiding service of national park has its limitations. For examples, static web guideline and restricted interaction interface. In such ecology guiding service can not provide the learners with adaptive learning. The learner does not gather enough ecology information from the traditional ecology guiding service. If the learner desires more ecology information to help them to find out more interests about the national park, they have to discover by themselves, or ask local ecology interpreter for more information. However, it is difficult to preserve the learner's learning experiences and pass down the oral interpretation.

In this study, the Scaffolding Theory and knowledge creation procedure are proposed to provide an adaptive ecology learning approach for the learners. Meanwhile, new wireless telecommunication technologies and interactive applications are used to construct a framework of adaptive ecology m-learning. In this framework, the learner can obtain ecology route planning and adaptive m-learning according to their inherent properties and extrinsic environmental factors as well as on-line interact with the interpreters by multimedia messages. These precious multimedia messages can be preserved and passed down, and then carry out efficient utilization of ecology information.

II. Literature Review

A. *Functions of National Park*

Taiwan, Formosa, a little island straddling the Tropic of Cancer, was known for hundreds of years as Formosa. Taiwan covers an area of 36,000 square kilometers, which is 0.025% of the total area on earth. Taiwan has undergone dramatic mountain building periods, interference by ice age, and is thus miraculously endowed with diverse ecosystems that range from the tropical to alpine. Taiwan has a diversified natural environment that includes high mountains and sea waters. Its unique and varied topography and ecosystems give rise to a multitude of compelling and captivating images. The movement for national parks and nature conservation in Taiwan began in 1961 and has since led to the establishment of seven national parks on the island from 1984, including Kenting, Yushan, Yangmingshan, Taroko, Sheipa, Kinmen and Dongsha Marine National Parks. Each national park owns it's unique characteristics and educational indicators. For instance, Kenting National Park, locates at the southern tip of Taiwan, possesses diversified terrain and tropical climate, and breeds rich and fertile vegetation ranging from upland to coast with a full variety of living species [8].

The aim of national parks in Taiwan is to maintain the unique natural environment and biodiversity within the parks through effective operation, management and conservation. Thus national parks should maintain three goals: preservation; education and recreation; and research[9]. In terms of characteristics and management methods, national parks have four functions: 1.To protect the natural environment , 2.To preserve species and native genetics, 3.To furnish national recreation and support the local economy, 4.To promote academic research and environmental education [8].The fourth function highlight that National parks are rich in ecology resources and through offering resources for scientific research and environmental education, they can contribute to people's understanding of the natural and cultural assets of the country. Therefore, national parks are not only providing functionality of travel and leisure, but also playing an important role of environment and ecology education. Thus, National parks should provide educational and recreational activities to develop public awareness of the beauty of nature and establish environmental values.

To sustainably conserve natural resources, national parks shall provide recreational activities such as eco- tourism to minimize environment impact. This could make from interpretation service, a method of national park management, and its role of communication between park administration, park resources and visitors is shown in Figure 1. Through interpretation, visitors can understand the goals of park resources management and obtain a joyful and safe tourism experience of national park. Also, it can create a knowledge-based recreation experience, reduce the visitors' activity impact on environment and improve the visitors understanding to park recreation. The interpretation service in national parks plays an important role in the overall quality of the parks. It can assist in explaining services provided by the parks, the eco-system of the area and management regulations emanating from the national parks' headquarters [10]. Therefore the purpose of interpretation is promoting environmental education and environmental awareness through appreciation, understanding and the new experience. Interpreters can purposefully make influence in how audiences think, feel and behave with respect to things they interpret.

The Food and Agriculture Organization of the United Nations (FAO) divide interpretation resources to three categories: geological feature, biological feature and human history. U.S. National Park Service defines interpretation resources to six categories: landforms of the present, geological history, land communities of plants and animals, aquatic ecosystems, historic and archeological themes, and works of humans. For instance, Kenting National Park, the site of Taiwan's first national park, is a popular tourist destination for locals and foreigners alike. Due to its geographical location, it has a tropical climate, which has resulted in rich natural resources and scenic landscapes, as well as a unique cultural style. It's interpretation resources include not only the six categories as mentioned, but also special sky landscape, such as "mountain winds" [11]. Therefore, it's important to provide efficient and suitable self-guiding interpretation information to different visitors in order to lead visitors into profound experience of Kenting's unique resources. How can interpretation really make a difference? This paper introduce some mechanisms, such as scaffolding and context awareness, try to illustrate a adaptive system that fit visitors various characteristic, diverse park resources and real-time environment changes in order to provide an optimized interpretation service.

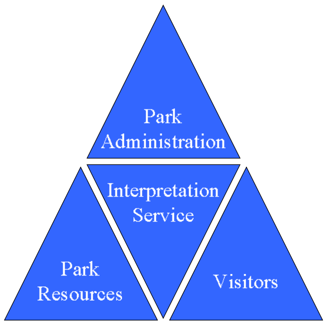

Figure 1 Relation between park administration, park resources, visitors and interpretation service

B. *Scaffolding Theory*

Scaffolding Theory was first introduced in the late 1950s by Jerome Bruner, used the term to describe young children's oral language acquisition and helped by their parents when they first start learning to speak, young children are provided with instinctive structures to learn a language. Wood, Bruner, and Ross' (1976) idea of scaffolding also parallels Vygotsky's work [12]. The term "scaffolding" was developed as a metaphor to describe the type of assistance offered by a teacher or peer to support learning. In the process of scaffolding, the teacher helps learner master a task or concept that learner is initially unable to grasp independently. The teacher offers assistance with only those skills that are beyond the learner's capability. The most significance is to allow the learner to complete as much of the task as possible, unassisted. The teacher only attempts to help learner with tasks that are just beyond his current capability. Learner errors are expected, but, with teacher feedback and prompting, learner is able to achieve the task or goal. When learner takes responsibility for or masters the task, the teacher begins the process of "fading", or the gradual removal of the scaffolding, which allows learner to work independently.

Scaffolding Theory proposes that teachers will act as assisting roles in the learning process to provide a temporary support (scaffold) in order to assist learners to construct self learning. Scaffolding Theory includes two main procedures, which are to setup the scaffold and phased removal of scaffold. The scaffold can be a teaching strategy or a teaching tool; it can be provision of clues, a reminder, encouragement, solution, providing an example or assistance through information technology. Meanwhile the learning responsibility is gradually shifted from teachers to learners and eventually learners can lead their learning [13]. That is to say, learners can construct knowledge of their own and develop themselves to be independent learners. Hwang, Lee and Chen's study [10] uses the interpretation service of five National Parks in Taiwan as an empirical study to create a relationship model for tourists' involvement, interpretation service quality and place attachment. Their results show tourists' involvement has a positive significant effect on perceived interpretation service quality, as does place attachment. Also, there is an indirect positive significant effect from place attachment to interpretation satisfaction. Therefore, self-learning with scaffold support is a feasible method to improve the satisfaction and knowledge transfer of interpretation of national park.

C. Adaptive Knowledge

In human-computer interaction, user interface events and frequencies can be recorded and organized into episodes. By computing episode frequencies and implication relations, we can automatically derive application-specific episode associations and therefore enable an application interface to adaptively provide just-in-time assistance to a user. Liu, Wong and Hui (2003) identify five issues related to designing an adaptive user interface: interaction tracking, episodes identification, user pattern recognition, user intention prediction, and user profile update. To adapt to different users' needs, the interface can personalize its assistance by learning user profiles or properties. For example, by detecting and analyzing users' behavior patterns in using Microsoft Word, the interface can automatically assist users in several Word tasks [14]. Personalized support for learners becomes even more important, when e-learning takes place in open and dynamic learning and information networks. Dolog, Henze, Nejdl and Sintek [15] proposed a service-based architecture for establishing personalized adaptive e-Learning systems with well-established personalization functionality, and open, dynamic learning repository networks, where personalization functionality is provided by various web-services. Computer can act as the supporter of knowledge construction by providing customized learning content which learners can Restructuring and construct to new knowledge and meaningful learning. Computer assist learning combined with integrated hypermedia interface can reveal information in nonlinear way and learners can reading the materials in their favorite order instead of in proper sequence. However, hypermedia system didn't present knowledge content in efficient linkage and ignore the relationships of knowledge. Some Web sites are intricate but not intelligent enough; while Web navigation is dynamic and idiosyncratic, all too often Web sites are fossils cast in HTML. Researches indicated the negative of traditional e-learning, such as : 1. Beginners lost the learning direction which cause the learning frustration , 2. Aimless browsing which cannot be construct to a comprehensive knowledge structure, 3. Overloading of information, 4. Weak relationship of information and hard to integrate the knowledge conception, etc [15-18]. Learners can not construct their own knowledge bases by making meaningful connections among the ideas as they perceive.

Therefore, adaptive web-based systems attempt to fight the "one size fits all" approach to e-learning. Farrell , Liburd and Thomas [19] describes one solution to the problem of how to select sequence, and link Web resources into a coherent, focused organization for instruction that addresses a user's immediate and focused learning need. Their Custom Course System consists of a Search Engine, the Dynamic Assembly Engine, and Course Player. A system is described that automatically generates individualized learning paths from a repository of XML Web resources. Each Web resource has an XML Learning Object Metadata (LOM) description consisting of General, Educational, and Classification metadata. Dynamic assembly of these learning objects is based on the relative match of the learning object content and metadata to the learner's needs, preferences, context, and constraints. Learning objects are connected into coherent paths based on their LOM topic classifications and the proximity of these topics in a Resource Description Framework (RDF) graph [19]. Brusilovsky [20] reviewed the adaptive functions, such as: 1.Adaptive textbooks created with such systems as InterBook, NetCoach or ActiveMath can help students learn faster and better, 2. Adaptive quizzes developed with SIETTE evaluate student knowledge more precisely with fewer questions, 3. Intelligent solution analyzers can diagnose solutions of educational exercises and help the student to resolve problems, 4. Adaptive class monitoring systems give the teachers a much better chance to notice when students are lagging behind, 5. Adaptive collaboration support systems can enhance the power of collaborative learning. He therefore presents an architecture for adaptive e-learning based on distributed reusable intelligent learning activities [20].

When interpreters present strongly relevant themes, their audiences are provoked to think in theme-related ways. Theme-related thinking impacts beliefs about the interpreter's topic, which, in turn, can impact attitudes and ways of behaving that are consistent with those beliefs [21]. The potential benefits include improved visitor management, local economic and environmental gains and fuller community involvement. However, there are several pitfalls of linking interpretation and sustainable tourism should be considered; those are the dangers of over-interpretation, intrusion, creating 'quaint' tourist landscapes, and those of elitism [22]. Therefore, the adaptive knowledge mechanism in this study is to provide learners adaptive guiding materials (subjects and levels) real-time according to the context (learner and environment) and the previous feedback records. Those adaptive materials include: 1. Personalized knowledge concept structure, 2. Relative linkage and resources, 3. Multimedia and virtual reality materials, 4. Dynamic and expandable nonlinear leaning support, 5. Interpreter's guiding and other learners' collaboration. Learners and interpreters can form a learning scaffold and add knowledge to empty grid of their knowledge scaffold by Play Jigsaw and Fill-in-the-Structure, and then complete their knowledge concept map. The adaptive knowledge mechanism based on Scaffolding can provide visitors suitable dynamic guiding materials according to their needs and interests in order to enhance their attitude to nature and self-learning.

D. Contex- Aware Computing

Context is an implicit situation information. For example, in the natural environment, weather is one of implicit situation information of context. The weather information of context is such as temperature, humidity and rain rate. If the information of context can be aware of change and treated with computing techniques, it should be to make interacting with computers easier. For example, if the sensor of air conditioner is aware of indoor temperature rising, the processor should inform the compressor to speed up the operation and release more cool air to lower the indoor temperature. Therefore, understanding how context can be used will enable designers to choose what context to be used in their applications, and help designers to determine what context-aware behaviors to be supported in their applications.

Most people tacitly understand what context is, but they find that it is hard to illustrate clearly. Brown *et al*. [23] define context as location, identities of the people around the user, the time of day, season, temperature, etc. Anind and Gregory [24] define context as: *Context is any information that can be used to characterize the situation of an entity. An entity is a person, place or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves.* This definition makes context-aware easier for an application designer to enumerate the context for a given application scenario. If a part of information of context-aware is used to characterize the situation of a participant in an interaction, then that information is context. For example, if the learner's location can be used to characterize the learner's situation, then the learner's location is context.

Schilit *et al*. [25] claim that the important aspects of context are: where you are, who you are with, and what resources are nearby. They define context to be the constantly changing execution environment. They include the following pieces of the environment:

- *Computing environment* available processors, devices accessible for user input and display, network capacity, connectivity, and costs of computing.
- *User environment* location, collection of nearby people, and social situation.
- *Physical environment* lighting and noise level.

A categorization of context types will help application designers to find out the pieces of context that will be useful in their application. There are certain types of context are: location, identity, activity and time[24]. The location is meaning that the learners' physical position presented by longitude and latitude. The identity represents the learner's properties such as age, gender, attitude, preference, knowledge-based and learning period. The activity includes an environment where the learner located, and events what occurrences happened in that environment. The time is the local time where the learner located.

Context-aware computing was first discussed by Schilit and Theimer [26] in 1994. Context-aware computing is similar to an application that "adapts according to its location of use, the collection of nearby people and objects, as well as changes to those objects over time". The first definition of context-aware application also given by Schilit and Theimer [26] restricted the definition from applications that are simply informed about context to applications that adapt themselves to context. Hull *et al*. [27] and Pascoe *et al*. [28-30] define context-aware computing to be the ability of computing devices to detect and sense, interpret and respond to aspects of a user's local environment and the computing devices themselves. Dey *et al.* [31] begin to introduce the notion of adaptation by defining context-awareness to be worked leading to the automation of an application system based on knowledge of the learner's context. Ryan [32] defines context-aware application to be applications that monitor input from environmental sensors and allow users to select from a range of physical and logical contexts according to their current interests or activities. Brown [33] defines context-aware applications as applications that automatically provide information and/or take actions according to the learner's present context as detected by sensors. Anind and Gregory [24] define context-aware as: *A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task*. This definition is more specific adapting to context and requiring that an application's behavior be modified for it to be considered context-aware.

E. Interactive Applications

In computer science, the term of interactive is referred to an application or software which receives and responses the input from humans. For example, the learner inputs multimedia messages or commands to an interactive application, then an interactive application makes an adaptive response to the learner. The interactive application, such as Web 2.0, has already been a trend of next generation application interface. The term of Web 2.0 is commonly associated with web applications which facilitate interactive information sharing, interoperability, user-centered design and collaboration on the World Wide Web [34].

The term of "Web 2.0" was created by Darcy DiNucci in 1999. In her article "Fragmented Future[35]", she writes:

> *The Web we know now, which loads into a window on our computer screens in essentially static screenfuls, is an embryo of the Web as we will know it in not so many years.*
>
> *The first glimmerings of Web 2.0 are now beginning to appear, and we can start to see just how that embryo might develop. The first stages of mitosis have begun, and the cells of the organism have begun to differentiate. Now we can see that the defining thing about the Web won't be any visible characteristic at all. The Web will be identified only by its underlying DNA structure—TCP/IP (the protocol that controls how files are transported across the Internet), HTTP (the protocol that rules the communication between computers on the Web), and*

URLs (a method for identifying files). As those technologies define its workings, the Web's outward form—the hardware and software we use to view it—will multiply. On the front end, the Web will fragment into countless permutations with different looks, behaviors, uses, and hardware hosts. The Web will be understood, not as screenfuls of text and graphics but as a transport mechanism, the ether through which interactivity happens. It will still appear on your computer screen, transformed by the video and other dynamic media made possible by the speedy connection technologies now coming down the pike. It will also appear, in different guises, on your TV set (interactive content woven seamlessly into programming and commercials), your car dashboard (maps, yellow pages, and other traveler info), your cell phone (news, stock quotes, flight info), hand-held game machines (linking players with competitors over the Net), maybe even your microwave oven (automatically finding cooking times for the latest products).

Web 2.0 is the network as platform, spanning all connected devices; Web 2.0 applications are those that make the most of the intrinsic advantages of that platform: delivering software as a continually-updated service that gets better the more people use it, consuming and remixing data from multiple sources, including individual users, while providing their own data and services in a form that allows remixing by others, creating network effects through an "architecture of participation," and going beyond the page metaphor of Web 1.0 to deliver rich user experiences [36].

F. *Wireless telecommunication Technologies*

The evolution of communication technology has been migrated gradually from wired to wireless, from narrowband to broadband, and from desktop to handheld. Digital information and multimedia can be obtained anytime and anywhere with available portable devices. The portable devices are such as Personal Digital Assistant (PDA), laptop, smart phone and netbook. These devices may surf internet using different wireless communication technologies. Several wireless telecommunication technologies are popular in the worldwide, such as HSPA (High-Speed Packet Access) and WiMAX (Worldwide interoperability for Microwave Access). HSPA includes two technologies: High-Speed Download Packet Access (HSDPA) and High-Speed Uplink Packet Access. HSPA is developed by 3GPP (Third Generation Partnership Project). It extends and improves existing WCDMA performance in packet data transmission rate. An advanced standard, Evolved HSPA, all called HSPA+, is soon to be release. HSPA increases packet data rates up to 14.4Mbps in the downlink and 5.8Mbps in the uplink, while HSPA+ further improves the performance of packet data rates up to 42Mbps in the downlink and 11Mbps in the uplink. The other popular wireless telecommunication technology is WiMAX based on IEEE 802.16 standard. It includes two main standards: 802.16-2004 is also called 802.16d referred to as "fixed WiMAX" and 802.16-2005 is also called 802.16e referred to as "mobile WiMAX". WiMAX is an OFDM-based physical layer providing packet data rates up to 144Mbps in the downlink and 35Mbps in the uplink. Both HSPA and WiMAX can provide broadband transmission to satisfy the bandwidth requirement of multimedia.

III. FRAMEWORK

In this study, a framework of adaptive ecology m-learning for national park is proposed. This framework is also based on Scaffolding Theory to provide an adaptive m-learning for learners.

A. *Framework*

In Figure 2, the learners can use laptop, netbook, PDA or any available devices which support wireless telecommunication technologies such as HSAP or WiMAX. These devices assist the learner to access to operators' base stations which provide radio signaling and connect to internet. Once the learners connect to internet, they can obtain adaptive content of ecology guiding information and interact with the interpreters via the scaffolding ecology m-learning system. The adaptive learning application server generates adaptive content according to the learner's inherent properties and extrinsic environment factors. In Figure 3 illustrates the learner's inherent properties consisting of age, gender, preference, knowledge-based and attitude, and the extrinsic environment factors consisting of location, time, weather, season and event. The learner's learning period means how much time the learner would like to spend on ecology learning. The learner can learn the ecology knowledge independently with the scaffolding ecology m-learning system, or learn the ecology knowledge collaboratively with other learners and interpreters through the scaffolding ecology m-learning system.

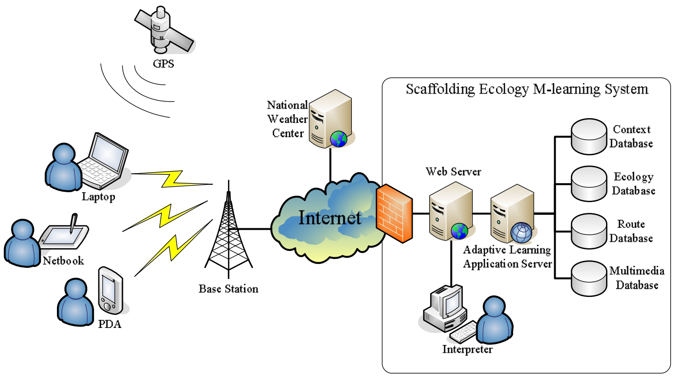

Figure 2 Framework

In this framework, four databases are deployed within the scaffolding ecology m-learning system. The Entity-Relationship Diagram (ERD) is shown in Figure 4. The context database stores the learner's inherent properties. The adaptive learning application server generates adaptive route plans based on context database and weather information retrieved from national weather center. The learner selects one of route plans, or asks the on-line interpreter to obtain a route plan depending on his/her interests. The ecology database stores related ecology information such as coastal and upland vegetations, animals, insects and marine creatures, etc. It can provide abundant resources of national park for the learners, or provide adaptive content for the learners based on their locations. The route database stores various paths for ecology guiding, travel and leisure. The route planning is based on the learner's properties and present environment factors to provide a suitable route planning for the learners. The multimedia database stores interactive messages such as text, audio, video and image from the learners or interpreters. For example, the learner records a piece of insect video, but he/she does not know what the insect is. He/She can upload the captured video to the multimedia database through the Web Server with Web 2.0 interactive application, and ask on-line interpreter about his/her question about unknown insect. The on-line interpreter searches the ecology database and responses the answer to the learner by multimedia messages. Therefore, in this framework not only provides adaptive content and suitable route planning, but also implement an interactive application between the learners and the interpreters.

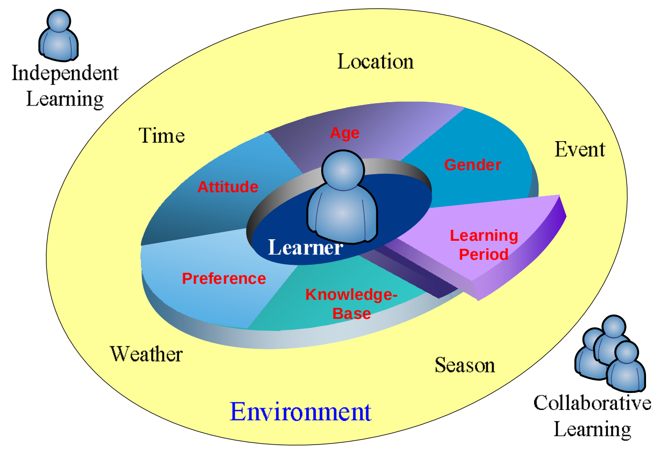

Figure 3 Learning context

The multimedia messages between the learners and the interpreters can be stored in multimedia database. These messages possess precious knowledge and experiences, and should be preserved. For example, if the learner records a piece of precious insect video, he/she can upload this video to the multimedia database through interactive application and share to other learners. Moreover, these messages can be preserved, shared and passed down through this framework.

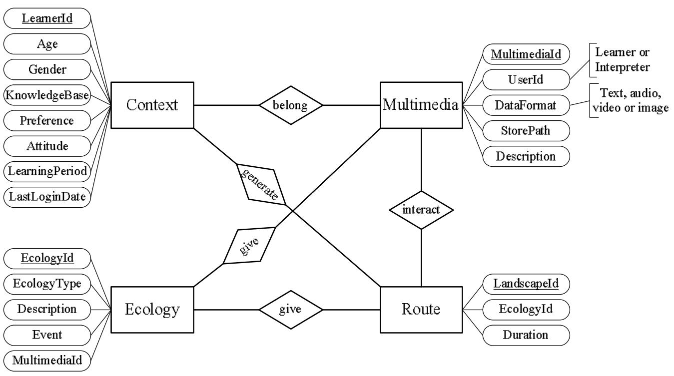

Figure 4 Entity-Relationship Diagram

B. *A Scaffolding m-learning model with Knowledge Creation process*

In Figure 5 illustrates that through "context check", "adaptive materials" and "knowledge construction" mechanisms based on Scaffolding Theory, learners can achieve self-guided leaning.

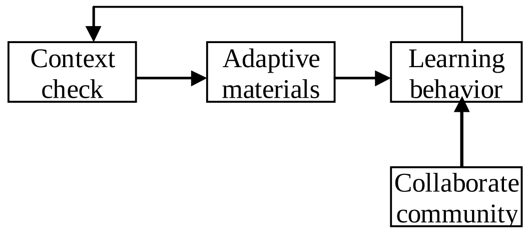

Figure 5 scaffolding m-learning model

Hogan and Pressley (1997) summarized the literature to identify eight essential elements of scaffold instruction that teachers can use as general guidelines as followings. Note that these elements don't have to occur in the sequence listed.

- Pre-engagement with the student (learner) and the curriculum
- Establish a shared goal
- Actively diagnose student needs and understandings
- Provide tailored assistance
- Maintain pursuit of the goal
- Give feedback
- Control for frustration and risk
- Assist internalization, independence, and generalization to other contexts

In order to assist learners to put what they learn into practice, this study makes use of further core knowledge management steps which are: creation, categorization, storage, sharing, updating and value [13]. In this study the listed above elements are applied to construct a scaffolding M-learning model with knowledge creation process, as shown in Figure 6.

Such a scaffolding m-learning model with knowledge creation process, the learners can understand more about the structure, connections, and combination of knowledge in ecology learning. The sharing and delivery quality of interpreter knowledge is also improved.

C. *Relative Techniques*

1) *Interactive Mechanism*

In this study, the interactive mechanism is an important feature in this framework. In Figure 7, a content delivery process is proposed with the interactive mechanism. The learner inputs personal properties, the system retrieves the environment factors from national weather center to generate an adaptive ecology content and/or provide a suitable route planning to the learner. It is a basic concept of interactive mechanism. An advanced interactive mechanism has to provide feedback function to the learner. It is important because the learner obtains desired adaptive content, the learner's knowledge can be improved, or called evaluated. Through feedback function, the learner's experiences can be fed back to the system, preserved to the database, and then passed down to other learners.

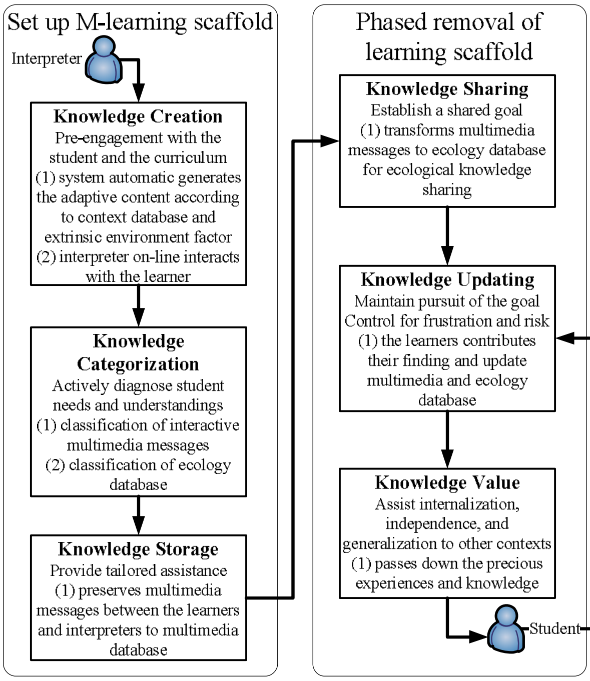

Figure 6 Scaffolding m-learning model with knowledge creation process

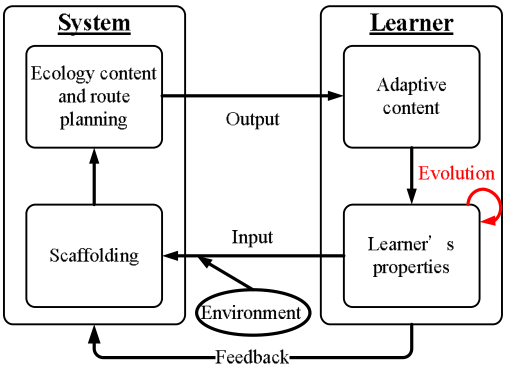

Figure 7 Content delivery process

2) *Context-Aware Computing*

The basic representation of how the context-awareness system functions as part of the content delivery system is illustrated in Figure 8. A learner with a mobile device is connected to adaptive learning application server, which in turn is linked to the context engine and database. The mobile device passes context state (input), learner context and environment context, obtained from national weather center, user input, and user profile to the context database which then compares this metadata to the content metadata provided by the content database and returns a set of content recommendations. These recommendations are used by the delivery system to determine which content to deliver to the learner, which is packaged as learning object (output), including ecology knowledge, route planning and peers experience.

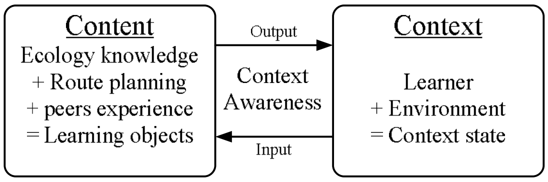

Figure 8 Context-aware schema

The primary purpose of adaptive learning application server is to perform intelligent matching between context metadata (i.e. input, metadata on learner and their setting, real-time environment factors) and content metadata (i.e. output, metadata on ecology knowledge, route planning, interpreter and other learners experience, services and options). By looking for content metadata that matches the metadata of the current context, the system can make recommendations about what content is appropriate. There are two crucial prerequisites for the successful completion of this process. First, available content must be appropriately marked up with a suitable metadata schema. Second, the system must have access to relevant metadata about the context, i.e. the learner's inherent properties and settings and extrinsic environment factors. The ordered list of ranked items of content is passed to content delivery subsystem for use in determining exactly what content should be made available to the user. In this way, the context-awareness system is intended only to make ranked recommendation route list to the system and to the user.

We consider this informal definition of context-awareness as a reference for our work. The LearnerProfile is a computer representation to structure a Learner's inherent properties that contains four components (PhysiologicalFactor, MotiveFactor, Cognition and Orientation).

[LeanerProfile

[PhysiologicalFactor [Age, Gender]]

[MotiveFactor [Attitude, Preference]]

[Cognition [Perceptual knowledge-base, Rational knowledge-base, Misunderstandings]]

[Orientation [Learning period, Problem, Goal]]

]

Any context-aware application or service depends on being able to obtain contextual information from the user's environment or setting. For this system, we anticipate relying on both automated input from sensors and other software and service such as weather server, and input from the user themselves about their state and the state of the world. Some possibilities for automated input include the use of location data derived from tracking a device within a wireless Local Area Network (LAN), GPS, and Bluetooth technology. Users also create their own context, and we anticipate the use of contextual metadata relating to both the learner status and learner profile above [37]. It has formed an important part of research into the design of intelligent interpretation systems.

3) *Route Planning Approach*

In this study, a route planning approach is proposed in this framework as shown in Figure 9. The route planning process requires two inputs: the learner's properties and the environment factors. The route planning process can be implemented by applying clustering algorithms to generate a suitable route plan for the learner. Clustering analysis or clustering is the process of classifying objects into subsets that have meaning in the context of a particular problem. It is a common technique for statistical data analysis used in many fields, such as machine learning, data mining, pattern recognition and image classification. Through the route planning approach based on clustering algorithm the output route plan provides a suggestion for the learners and assists the learners to enjoy the ecology learning.

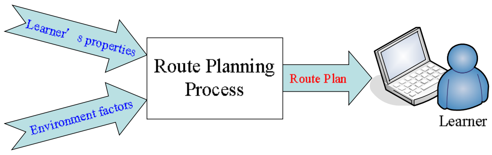

Figure 9 Route planning approach

D. *Examples*

In this study, all of related ecology guiding information and interactive application can be delivered to learners' portable devices such as netbook, notebook and PDA through mobile telecommunication networks such as HSPA and WiMAX. We assume that the learner plans to have a ecology learning with a netbook which equipped HSPA data card. We provide two scenarios for example.

Scenario 1: If the learner is a new user, the learner has to register his/her properties first. Then the system, the scaffolding ecology m-learning system, will generate a suitable route planning according to his/her properties and current environment factors, which is a good assistance for beginners to find the targets of nature observation. During the ecology learning, if the learner finds out a unknown organism, for example the coastal vegetation community, the learner can on-line requests an assistance and interacts with the interpreter. The learner can make photos for that unknown organism and submits these photos to the interpreter, then the interpreter will search a solution from ecology database and responses the explanation to the learner.

Scenario 2: The learner has registered to the system before and used this system to have an ecology learning. Therefore, the learner's properties has been stored in context database. The system allows the learner to update his/her newest properties such as age, preference or knowledge-base. When the learner uses netbook to connect with internet via HSPA or WiMAX data card and logins this system again, the system will provide a suitable route planning according to learner's properties and current environment factors such location, time and weather, etc. During the ecology learning, the system not only real-time provides ecology information by text, photos or videos, but also informs the learner to pay attention for changing of ecology environment. For example, during September, an amazing number of Chinese goshawks will pass through Hengchun Peninsula, or in October, Gray-faced buzzards, following Chinese goshawks' southbound migrating track, continue to pass through Hengchun Peninsula. The learner can on-line interact with the interpreters by text, photo, or video when events occurred on the way of route. Through this system the learner can learn independently. When the learner finishes his/her ecology learning and gathers new ecology knowledge, he/she can maintain his/her property of knowledge-base in context database. Meanwhile, by using this system the learner can share his/her precious experiences and knowledge of ecology learning to other learners. Furthermore, interactive information of ecology can be stored on multimedia database, shared to learners, and transferred experiences to knowledge of ecology education.

IV. Conclusion and Future Work

In this study an approach is proposed to take scaffolding and context awareness into account for the area of ecology education and learning, and telecommunication technologies are used to connect between the learners, the interpreters and the scaffolding ecology m-learning system through internet. This framework has shown how adaptive functionalities can be embedded into mobile interpretation services for retrieving ecology resources and suitable ecology route plans to enjoy the benefits of ecology guiding service. The interactive messages between the learners and the interpreters through knowledge creation procedure can be preserved, shared and passed down. Eventually, the learners obtain ability of how to learn independently and how to share their precious experiences.

Based on this framework, the integrations of ecology guiding service and user interface and implementations of interactive application, location-based service and multimedia messages are considered. The pilot run will be built up in future work.

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