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Scaffolding ecology m-learning with knowledge creation

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ABSTRACT: This study proposes a framework based on Scaffolding theory that provides learners with mobile, dynamic and adaptive ecology guiding and learning services. The traditional ecology guiding service uses static webpages or fixed placards to prompt and provide ecology information to learners; learners cannot obtain real-time ecology guiding information and cannot have good adaptive learning based on learners' knowledge background, time and location. To overcome the limitation of traditional ecology guiding services, an adaptive scaffolding ecology m-learning framework applied to national parks is proposed in this study. In addition to context-aware knowledge creation, flow learning that emphasises experiential learning and has emotional and spiritual connections to nature is described in scenarios. This scaffolding m-learning system can be used in virtually any field of learning in engineering and technology education to build group cohesiveness and to experience more deeply the harmony of environment.

INTRODUCTION

A *national park* is an area with a country's special features or cultural or historic significance. By adopting a sustainable interpretation with profound experience and respect to nature in ecology tourism, visitors can observe and learn from nature and, then, the sustainable management of national parks can be achieved [1-5]. Therefore, ecology education is an important function of national park management. Working out how to use new technologies to improve national park services to enable more people to enjoy, understand and teaching them how to improve the natural environment, is the intention of this study.

In this study, Scaffolding theory and knowledge creation procedures are proposed to provide an adaptive ecology learning approach for learners. Meanwhile, new wireless telecommunication technologies and interactive applications are used to construct a framework of adaptive m-learning. Learners can obtain ecology route planning and adaptive m-learning according to their inherent properties and extrinsic environmental factors, as well as on-line interaction with the interpreters via multimedia messages. These valuable multimedia messages can be preserved and passed down to enable the efficient utilisation of ecology information.

LITERATURE REVIEW

Functions of National Park

Taiwan is a little island straddling the Tropic of Cancer and was known for hundreds of years as Formosa. Taiwan covers an area of 36,000 square kilometres, which is 0.025% of the earth's total land area. Taiwan has a diversified natural environment that includes high mountains and seawater. 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 eight national parks on the island from 1984. These are Kenting, Yushan, Yangmingshan, Taroko, Sheipa, Kinmen, Taijiang and Dongsha Marine National Parks. Each national park owns its unique characteristics and educational indicators. 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 [6]. To conserve natural resources sustainably, national parks should provide recreational activities such as eco-tourism to minimise environmental impact.

This could range from interpretation services through to the method of national park management, and maintaining close connections between park administration, park resources, visitors, and interpretation service needed. Through interpretation, visitors can understand the goals of park resources management and enjoy a pleasant and safe tourism experience of the national parks. In addition, it can create a knowledge-based recreation experience, reduce the visitors' activity impact on the environment and improve the visitors' understanding of park recreation.

Flow Learning

For ecology guiding service of national parks, it is essential that every effort is made to keep visitors in touch with the earth and more aware of the world around them. The challenge is how to use nature to stimulate joyful, enlightening insights and experiences. Cornell [7][8] presented his flow learning system of nature awareness, which can help teachers, parents or nature guides tune into a group's level of enthusiasm and lead them into an enjoyable appreciation of the nature world and many other subjects as well. This practical, easy-to-use tool has four stages; Stage 1: Awaken enthusiasm; Stage 2: Focus attention; Stage 3: Direct experience; Stage 4: Share Inspiration. Naturalist and author Cornell bases his teaching on five rules of outdoor teaching: teach less and share more; be receptive; focus the child's attention rapidly; look and experience first, then talk; and let the experience be joyful. In this study, this technique is adopted in order to guide and design activities to gauge learners' interest sensitively and structure the subject matter appropriately and creatively. These carefully designed stages make it easy for interpreters to choose activities appropriate to a group's age, mood and physical environment.

Scaffolding Theory

Scaffolding theory was first introduced in the late 1950s by Jerome Bruner, who 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' idea of scaffolding also parallels Vygotsky's work [9]. Scaffolding theory proposes that teachers will adopt an assisting role 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 and solutions, 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 [10]. That is to say, learners can construct knowledge of their own and develop themselves into independent learners. Hwang, Lee and Chen's study 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 [11]. Their results show tourists' involvement has a positive significant effect on perceived interpretation service quality, as does place attachment. In addition, there is an indirect positive significant effect from place attachment to interpretation satisfaction. Therefore, self-learning with scaffold support is a feasible method for improving the satisfaction and knowledge transfer of interpretation of national parks.

Adaptive Knowledge

Computer-assisted learning combined with integrated hypermedia interface can reveal information in a non-linear way and learners can read the materials in their favourite order instead of in the proper sequence. However, hypermedia systems do not present knowledge content in efficient linkages, and they ignore the relationships of knowledge. Some websites are intricate but not intelligent enough. Research has indicated the negative aspects of traditional e-learning, such as: 1) beginners lose their learning direction which causes learning frustration; 2) aimless browsing, which cannot be constructed into a comprehensive knowledge structure; 3) information overload; 4) weak information relationships, and it is hard to integrate the knowledge conception, etc [12]. Learners cannot construct their own knowledge bases by making meaningful connections between the ideas as they perceive them.

Therefore, adaptive Web-based systems attempt to find the *one size fits all* approach to e-learning. Brusilovsky 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 analysers 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 [13]. He, therefore, presents an architecture for adaptive e-learning based on distributed reusable intelligent learning activities [13].

The adaptive knowledge mechanism in this study is to provide learners with adaptive guiding materials (subjects and levels) in real-time according to the context (learner and environment) and the previous feedback records. Those adaptive materials include: 1) personalised 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 the 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.

Context-Aware Computing and Interactive Applications

Context-aware computing was first discussed by Schilit and Theimer in 1994 [14]. 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* [14]. The first definition of context-aware application also given by Schilit and Theimer [14] restricted the definition from applications that are simply informed about context to applications that adapt themselves to context. Hull et al [15] and Pascoe et al [12][16][17] define context-aware computing as being 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. Context is implicit situation information. For example, in the natural environment, weather is implicit situation information of context. If the information of context can be aware of change and treated with computing techniques, it should be possible to make interacting with computers easier. Therefore, understanding how context can be used will enable designers to choose what context can be used in their applications, and help designers to determine what context-aware behaviours to be supported in their applications.

Wireless Telecommunication Technologies

The evolution of communication technology has 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. Portable devices include Personal Digital Assistants (PDA), laptops, smart phones and netbooks. These devices can be used to surf the Internet using a range of wireless communication technologies. Several wireless telecommunication technologies are popular in the world, including HSPA (High-Speed Packet Access) and WiMAX (Worldwide interoperability for Microwave Access). HSPA technology 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. WiMAX technology provides 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.

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.

Framework

In Figure 1, the learners can use laptop, netbook, PDA or any available devices that support wireless telecommunication technologies such as HSPA or WiMAX. These devices assist the learner in accessing operators' base stations which provide radio signals and connect to the Internet. Once the learners connect to the 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.

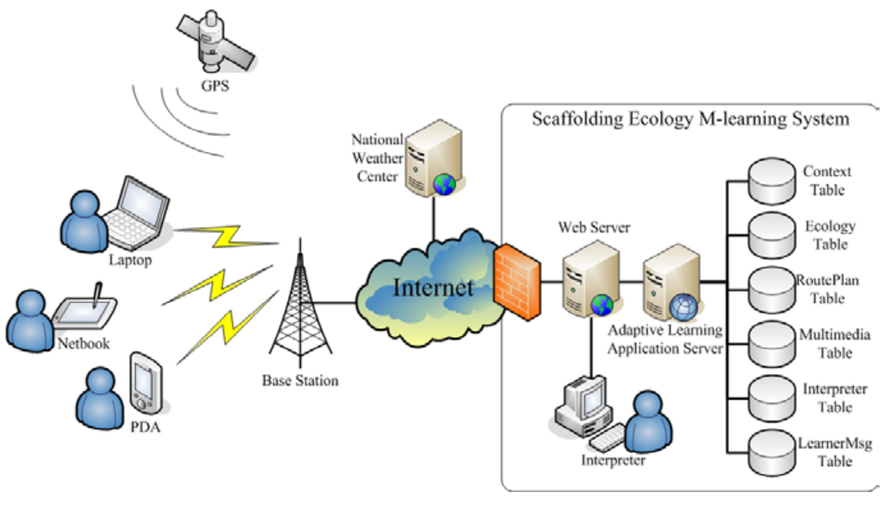

Figure 1: Framework.

Figure 2 illustrates the learner's inherent properties consisting of age, gender, preference, knowledge-base, attitude and learning period. The extrinsic environment factors consist of location, time, weather, season and event. 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.

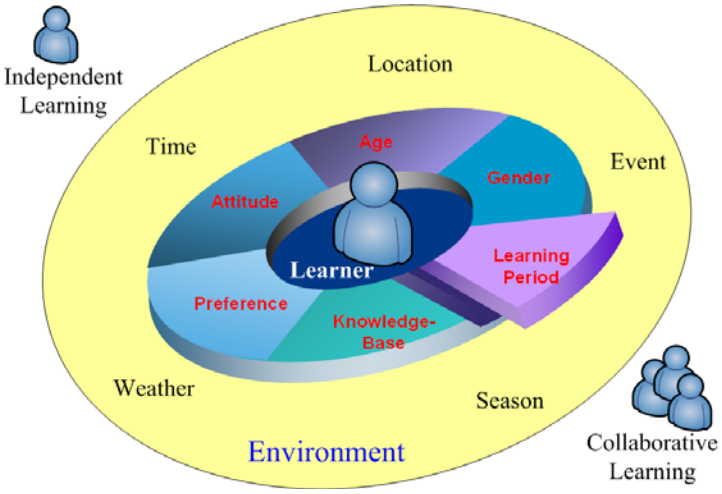

Figure 2: Learning context.

In this framework, four tables are deployed within the scaffolding ecology m-learning system. The Entity-Relationship Diagram (ERD) is shown in Figure 3. The Context table 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 centre. The learner selects one of the route plans or asks the on-line interpreter to obtain a route plan depending on his/her interests. The learner blog will also be created according the Context and LearnerMsg tables. The learner can maintain their personal profile and learning experience on-line. Learning experience will be stored in LearnerMsg table.

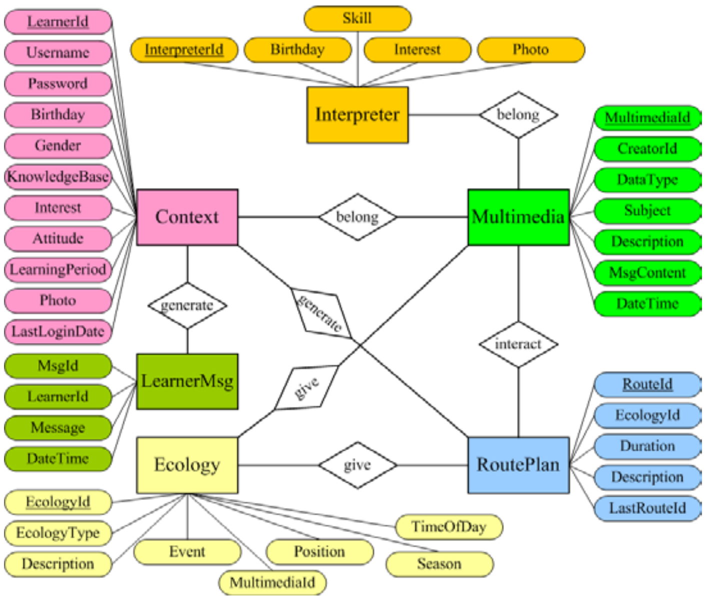

Figure 3: Entity-relationship diagram.

The Interpreter table includes interpreter's basic information such as birthday, skills, interests and life photo. The Ecology table stores related ecology information such as coastal and upland vegetations, animals, insects and marine creatures, etc. It can provide abundant resources about the national park for the learners, or provide adaptive content for the learners based on their locations. The RoutePlan table 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 suitable route planning for the learners.

The Multimedia table 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 the on-line interpreter for his/her question about unknown insect. The on-line interpreter searches the Ecology table and answers the learner via multimedia messages. Therefore, this framework not only provides adaptive content and suitable route planning, but also implements an interactive application between the learners and the interpreters. The practical table creation and relationship between tables is shown in Figure 4.

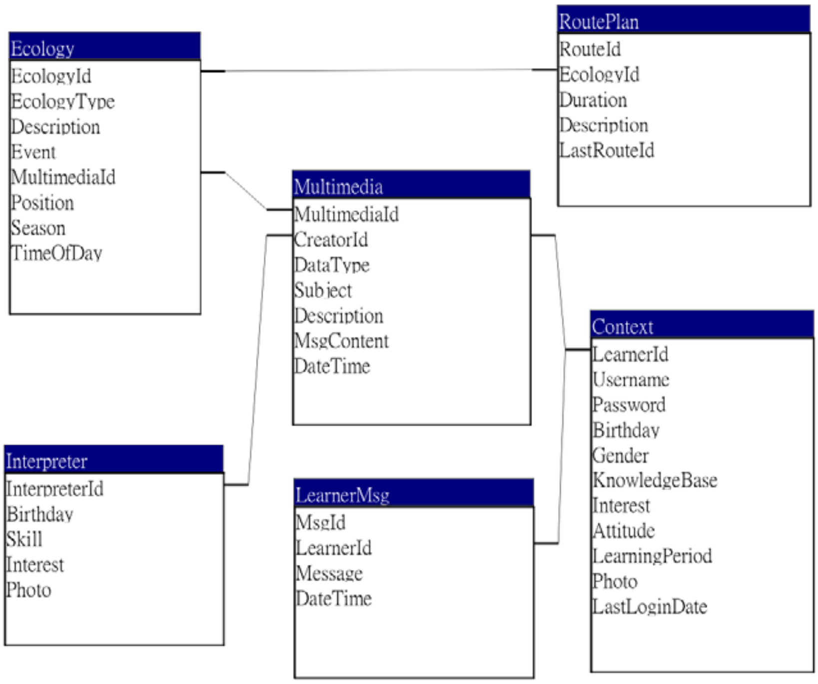

Figure 4: Table relationship diagram.

Scaffolding M-Learning Model with Knowledge Creation Process

Hogan and Pressley summarised the literature to identify eight essential elements of scaffold instruction that teachers can use as general guidelines [18]. These eight elements are: 1) pre-engagement with the student (learner) and the curriculum; 2) establish a shared goal; 3) actively diagnose student needs and understandings; 4) provide tailored assistance; 5) maintain pursuit of the goal; 6) give feedback; 7) control for frustration and risk; 8) assist internalisation, independence, and generalisation to other contexts. Note that these elements do not have to occur in the sequence listed.

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, categorisation, storage, sharing, updating and value [10]. In this study, the elements listed above are applied to construct a scaffolding m-learning model with knowledge creation process, as shown in Figure 5.

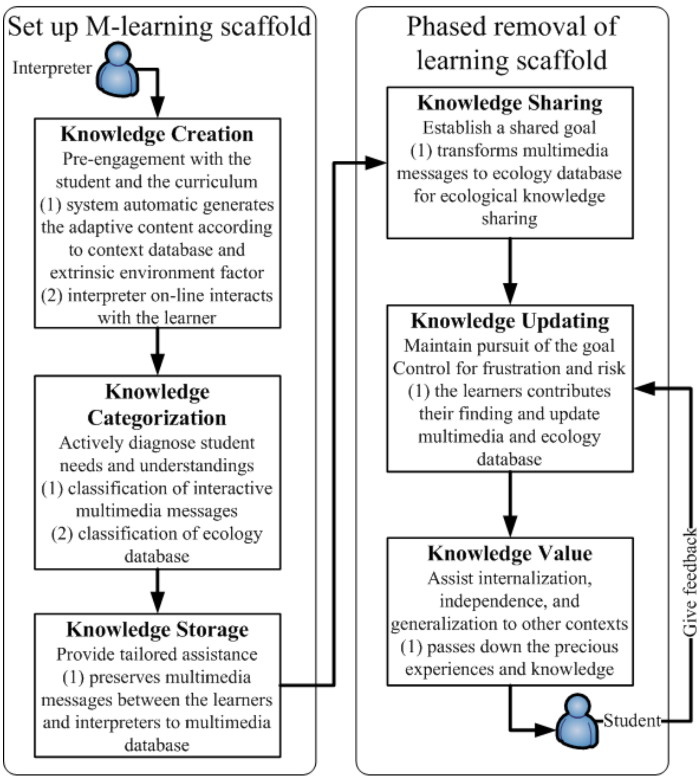

Figure 5: Scaffolding m-learning model with knowledge creation process.

Such a scaffolding m-learning model with a 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.

Relative Techniques

Interactive Mechanism

In this study, the interactive mechanism is an important feature in this framework. In Figure 6, a content delivery process is proposed with the interactive mechanism. The learner inputs personal properties, the system retrieves the environment factors from national weather centre to generate adaptive ecology content and/or provide a suitable route planning to the learner. It is a basic concept of an interactive mechanism.

An advanced interactive mechanism has to provide a feedback function to the learner. It is important because the learner obtains the 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.

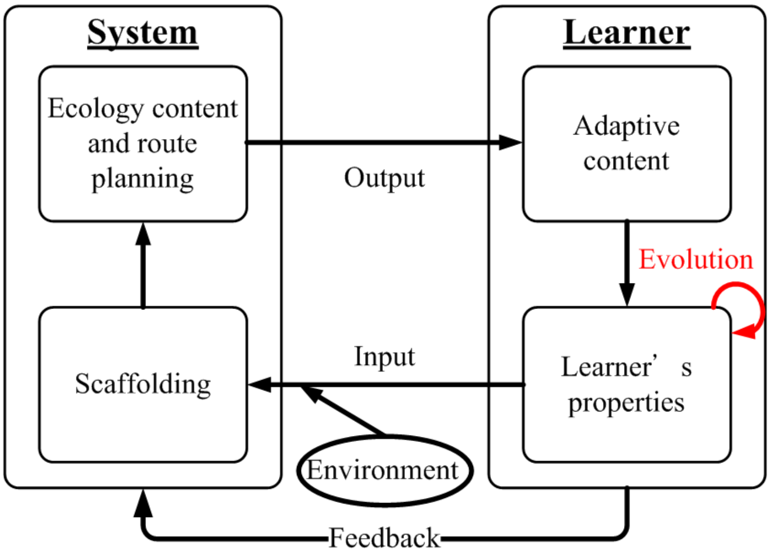

Figure 6: Content delivery process.

Context-Aware Computing

The basic representation of how the context-awareness system functions as part of the content delivery system is illustrated in Figure 7. A learner with a mobile device is connected to the 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 centre, user input, and user profile to the Context table, which then compares these metadata to the content metadata provided by the Context table 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.

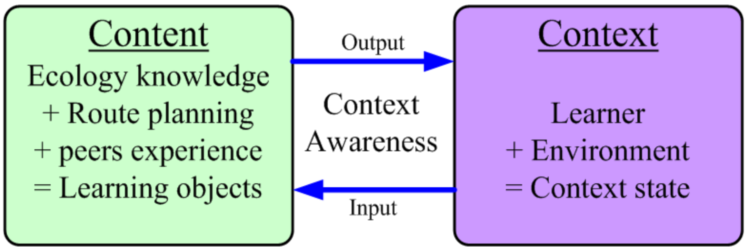

Figure 7: Context-aware schema.

One should consider this informal definition of context-awareness as a reference for this work. The LearnerProfile is a computer representation to structure a learner's inherent properties that contains four components: PhysiologicalFactor, MotiveFactor, Cognition and Orientation. It has formed an important part of research into the design of intelligent interpretation systems.

[LeanerProfile
  [PhysiologicalFactor [Age, Gender]]
  [MotiveFactor [Attitude, Preference]]
  [Cognition [Perceptual knowledge-base, Rational knowledge-base, Misunderstandings]]
  [Orientation [Learning period, Problem, Goal]]
]

Route Planning Approach

In this study, a route planning approach is proposed in this framework as shown in Figure 8. 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 the clustering algorithm, the output route plan provides a suggestion for the learners and assists the learners to enjoy the ecology learning.

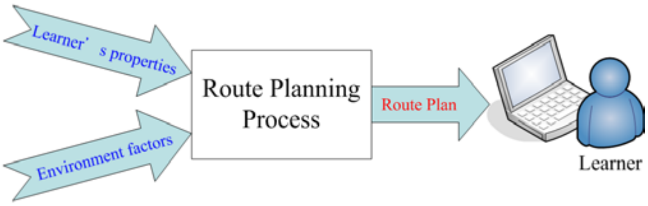

Figure 8: Route planning approach.

Examples

In this study, all of the related ecology guiding information and interactive application can be delivered to learners' portable devices such as their netbook, notebook or PDA through mobile telecommunication networks such as HSPA and WiMAX. It is assumed that the learner plans to have ecology learning with a netbook, which is equipped with a HSPA data card. The scaffolding ecology m-learning system will generate a suitable route and activity planning according to his/her properties and current environment factors, which is good assistance for learners to find the targets of nature observation dynamically. Two routes are provided, for example, the Eluanbi Park, Taiwan's southern cape, which is known as *Taiwan's Tail*. The Eluanbi Park covers an area of 59 hectares. Within the park, there are a number of recreational facilities and a wide range of interesting geological, botanical and ornithological features.

- Route planning 1:
  Time: 0.5 hours;
  Seasons: four seasons;
  Age: 2 years and older;
  Group Size: 2 or more;
  Knowledge Base: none;
  Skills: appreciating nature;
  Route: Gateway to Sea Pavilion and return;
  Subjects: Pillar Rock, Kissing Rock (coral rocks and cliffs); Sea view of Bashi Channel, Maobitou, Mt. Dajian (landmarks); Odollam erberus-tree, Screw Pine, Zebra Wood (unique coastal plants and seashore plants). The visit time is limited and the route is main to let learners experience the sea breeze and enjoy nature.
- Route planning 2:
  Time: 2 hours;
  Seasons: spring and fall;
  Age: 6-13 years;
  Group Size: 5-20;
  Knowledge Base: basic;
  Skills: environmental awareness, observation, identification;
  Route: Gateway, Sea Pavilion, Twisted Banyan, Antique Cave, Narrow Gorge, Mystery Cave, Main Grass, Eluanbi Lighthouse, Gateway;
  Subjects: Pillar Rock, Kissing Rock, Narrow Gorge, Mystery Cave (coral rocks and cliffs); Sea view of Bashi Channel, Maobitou, Mt. Dajian (landmarks); Odollam Erberus-tree, Zebra Wood, Screw Pine, Reef Pempfis, Scaevola (unique coastal plants and seashore plants); Styan's Bulbul, Muller's Barbet, Camaena Batanica Pancala, Swinhoe's Tree Lizard, Tree Nymphs (butterflies) and numerous animals to be discovered.

The system can assist learners to find the observation subjects and interact on-line with the interpreters by multimedia messages. Once a child's interest and energy is awakened and focused, the stage is set for deeply experiencing nature.

The experiential activities have a dramatic impact that involves people directly with nature. The games help students discover a deep, inner sense of belonging and understanding. For example, at Twisted Banyan, the *Heartbeat of a Tree* activity and at Grass, the *Sound Map* activity and *Roll and Jump* activity can let child experience deeply the nature, using their five senses and body instead of just knowledge. Teach less and share more and let the experience be joyful. Meanwhile, with interaction and feedback to others in system, they will have deeper impressions.

CONCLUSIONS

How do we educate for a different world, one in which sustainability becomes a priority for the growing human population and the diminishing biodiversity of other species? For the most part, environmental education has been included in the science curriculum in schools or the programs of park naturalists and interpreters. Experiential learning can help people form a spiritual and emotional connection with the ecological systems of which they are a part.

In this study, an approach was proposed to take scaffolding and context awareness into account for the area of experiential ecology education and learning, and telecommunication technologies are used to connect between the learners, the interpreters and the scaffolding ecology m-learning system through the Internet. This framework has shown how adaptive functionalities, such as learners properties and environment factors, can be embedded into mobile interpretation services for retrieving ecology resources and suitable ecology route and activity plans to enjoy the benefits of nature experiential learning.

The interactive messages between the learners and the interpreters through knowledge creation procedure can be preserved, shared and passed down on this m-learning system. 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. Eventually, the learners obtain ability of how to learn independently and how to share their precious experiences. By using this system the learner can share his/her precious experiences and knowledge of ecology learning to other learners and, furthermore, interactive information of ecology can be stored on multimedia database, shared to learners and transferred experiences to knowledge of ecology education. This interactive scaffolding m-learning system can be expanded in field learning of technology education to build group cohesiveness and to experience more deeply the harmony of environment.

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