Activity Generator for Informal Learning in Museum

Chun Chang[1], Stis Wu[1] , Maiga Chang[2], Jia-Shen Heh[1]
[1]Dept. of Information and Computer Engineering, Chung-Yuan Christian Univ., Taiwan
[2]School of Computer and Information System, Athabasca University, Canada
daniel@mcsl.ice.cycu.edu.tw, stis@mcsl.ice.cycu.edu.tw, maiga@ms2.hinet.net,
jsheh@ice.cycu.edu.tw

Abstract: - Informal learning has some benefits for students as: (1). Learning out of school. (2). Students can decide activity for themselves. Museum is chosen for our research because it is one of the informal learning and has variety of domain knowledge. Furthermore we want to enhance the museum learning to be more efficiently. The m-learning is chosen because the benefit of m-learning could leads students making their own knowledge in variety context. The context-awareness knowledge structure is used to manage knowledge such as learning objects and characteristics. Learning objects are as the antiques and characteristics are as the antiques` features "color", "shape". The knowledge will be embedded in each activity. However, we desire to lead activities attractive for students. Hence the elements of game-based learning are appended into activities as "challenge", "fantasy", "control".

Key-Words: **museum learning, game-based learning, context awareness, mobile device, personalized activity.**

1 Introduction

Teacher-led classroom is the traditional instruction in the past. Students could not observe and touch the learning objects in real environment. Hence the informal learning was constructed to let instructions different from traditional ones. it is one kind of instruction that students can learn in a real learning environment by contact with learning objects. For instance, museum is an informal learning which has abundant knowledge such like color and shape characteristics therefore this research chooses it in our research to build the Activity generator.

For making museum learning more useful, there are two issues we try to overcome. First issue is how to make learning for fun. The solution in this research is making the learning as a game. And then, this research appends some characteristics of the game-based learning such as "control", "challenge" to use in museum learning. Second issue is how to make museum learning more efficiently. To solve that we embed the elements of the m-learning within museum learning such as using handhold device, wireless technology to sensor the context.

2 Background

2.1 Entropy & Information theory

The entropy of partition is a measurement in granularity of the partition. If partition is unique, it means that the entropy value of the entropy function is maximum. On the contrary, there is only a partition to represent the value is 0. The entropy function would like as following: [12]

$$H(P) = \sum_{i=0}^{k} \frac{r_i}{n} \log_2 \frac{n}{r_i}$$

H(P): entropy of partition P
r_i: cardinality
k: whole division of the data
n: quantity of the data. □

Information theory is a method about logarithmic based to measure information. It chooses '2' is to fit the computer basic unit such like a bit is 1 or 0 [3]. The data is importance or not depending on the probability. In this research, the probability means the amount of the feature within the same type features. The information is higher and the feature is less important. The equation is showing as following:

$$I(F_i) = \log_2(\frac{1}{P_{F_i}})$$

P means the probability.
F_i means the Feature I about the antiques.
$I(F_i)$ means the information about the feature i. □

2.2 Rough set

Rough set is an approach about the ambiguity. Each rough set has some objects that cannot be classified clearly, and those objects are in the boundary region. We often use rough set in the knowledge discovery, pattern recognition. The advantage of the rough set is that we do not need to get other information as the support, confidence to

assist us to analysis the relation of the data [9]. The definitions about the three regions of rough set are:

(1). Positive set: All elements within positive set can be classified uniquely.
(2). Boundary set: All elements within boundary set can not be classified uniquely.
(3). Negative set: All elements within negative set are not interesting to analyzer.

2.3 M-learning

Mobile learning is always with portable technology and across context. A former research had shown "mobile technology can offer new opportunities for learn that extends beyond the traditional teacher-led classroom". The key characteristics of mobile learning are [13]: (1). Learners can build knowledge in variety contexts. (2). Learners can build comprehension. (3). Mobile technology often changes the pattern of learning activity. Through the technologies keep improving, there is a new method as the ubiquitous learning that embeds the various devices in the everyday, around our persons, and in the devices we carry [2].

2.4 Context awareness

The context-awareness achieves the situated learning by handheld device, wireless technology and sensors. It can be applied as a computing environment to understand user's behaviors [14]. For example, the features of context awareness is to aware personal statement such as the action, the location, the temperature and so on. Now, this research also applies context awareness in learning environment to realize learner's profile, learning experience. In this learning environment, learning could not be interrupt by learner movement and changing devices.

2.5 Museum learning

Museum is a place which has plentiful knowledge which distributes over different domains could be learned. Museum learning is a kind of the informal learning. It means that the learning outside of school [8]. The museum learning with mobile devices has some characteristics: (1). Mobile device can perceive the sensors and transmit data with context-awareness server. (2). Learning process and the content are interesting with visitors or learners [14]. The types of the mobile applications already had been used in the museum are delivering information to the visitor, providing tools that can support the learning processes, and presenting an educational scenario. These systems assist learner to visit in the museum by some mobile devices [8].

Koji Yatani provides the Musex system to expresses children in the museum learning activity which supported with some mobile device could explore proactively, pay attention to the exhibitions with less attractive, and have more motivation to learn in the museum [6]. Another research, Axel Feix provides the DinoHunter system which uses the mobile edutainment activity in the museum to enhance the student's learning motivation [4].

2.6 Game-based learning

Carmelo Ardito in 2007 uses a game to provide the way in learning history. There are three advantages to explain that game is good at learning: (1). play is fun, (2). learning with enjoyment could probably decrease to forget what players learn, and (3). play is an activity about society. It develops our generalization and conceptualization about the learners learning gained [1]. Fig 1 shows the game cycle: [11][10][5] This game-play model has input, process and outcome is similar with traditional learning model. In those models, user can play the game repeatedly by using the related iterative process in Fig 1.

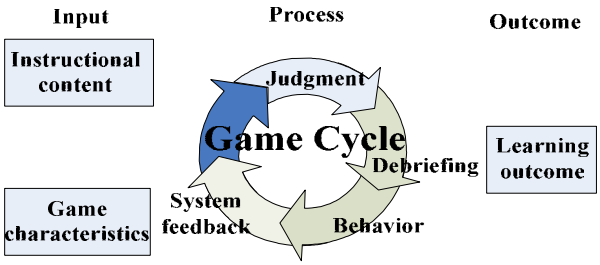

Fig. 1 The Game Cycle

Learners can learn and practice through repeating the three processes: judgment➔behavior➔feedback could cause them to improve the confidence, interest, getting better effort, and getting system feedback about the performance. Finally they will get learning outcomes and results when they finish a game. A game could have motivation to user depends on four elements. These elements are challenge, fantasy, curiosity, control. The descriptions about the four elements as following [11]:

Challenge: There is the unit to represent the challenge in game: goal. Goal completed or clear is important to computer games as called a challenge for player. These make player to do his/her best in games. In order to make games interesting. Challenge could be making the goals to be variable difficulty levels and multi goals must be overcome

in the same round.

Fantasy: Fantasy means that the game-based learning uses real and virtual world to simulate the real learning environment. A game have fantasy will impress and interest to user.

Curiosity: Curiosity is making the motivation to learn. A computer game is curiosity or not to the players depending on the context.

Control: It means that user can indicate and dominate goals or preferences by themselves. Morrison in 1992 provides that students select the context and number about the questions they need to accomplish could lead them learning actively [11]. The percept of control with user is induced within a game by selecting strategy, and managing the path of the activity.

Hence, game-based learning will make learning more interesting, motivating and effective. There are two researches shown the game-based learning is better [7] [11].

3. Methodology

Section 3 will use an example to introduce the three steps about the activity generator.. There is a student whose name is Kidd. Today, Kidd goes to museum. However Kidd don't know how to find the antiques and just watch the antiques that s\he interests and visits for fun. Kidd asks a museum guilder for help and guilder realizes his\her problem. And then, they give him\her a PDA with activity generator system.

Step1. Deciding the main feature

The first step, Kidd chooses his interesting feature "pottery" in PDA. Hence, the activity generator system will make the "pottery" to be the main feature and begin to generate activities.

In generating learning activities, there are two issues must be considered: relation between antiques and features about the main feature and the difficulty in each activity. The details will be shown as following step 2 and step 3.

Step2. Relations between antiques and main feature

Because, Kidd chooses the main feature is "pottery". First, using rough set to discover the antiques about the main feature "pottery", and then analyze the relations among the antiques by different kinds of secondary features. Hence the negative region does not contain the "pottery", so the feature "ivory" does not be considered in the relation analysis. The illustration shows in Fig 2.

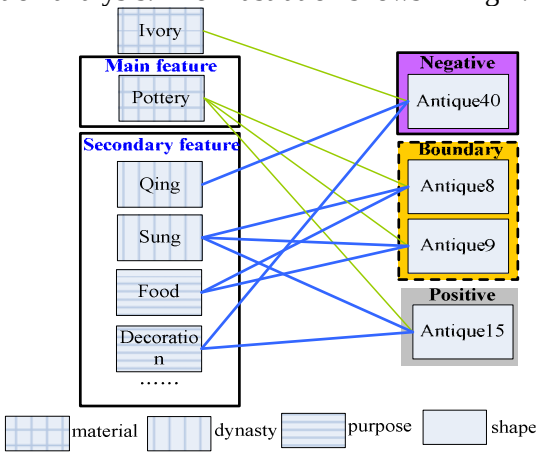

Fig. 2 Relations analysis about the "pottery"

Therefore the antique's group about "pottery" could be divided into three subgroups by the types of the secondary features. According to the type "shape", "purpose", "dynasty", there are three subgroups of the antiques could be analyzed by rough set separately. There are three series of activities could be generated. The learning activity has the learning goals such like "know the shape of the pottery", "know the purpose of the pottery", "know the dynasty of the pottery". Fig 7 is an instance that the candidate feature type is "dynasty".

Hence, the relations between antiques and features are about the series of activities "pottery's dynasty". Following the step 3 shows the calculating the degrees of the difficulty about learning activities.

Step3. Deciding the degree of the difficulty at each activity

In previous step, system can discover the how many activities which relate with "pottery" and system can not decide the order of the same series of activities.

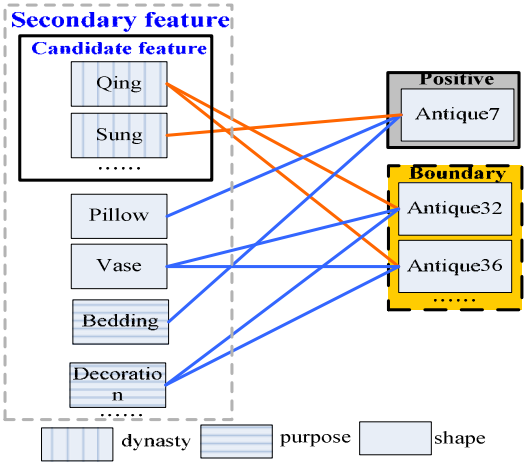

Fig.3 Relation analyses in series activities "pottery's dynasty"

In this phase, system will calculate the degrees of difficulty in each activity and uses entropy to get the activity complexity. Fig 3 shows the Relation analyses in series activities "pottery's dynasty".

Fig 4 and Fig 5 are the details to get the entropy about the "pottery at Qing" activity.

About shape:

There are four feature values in "shape": vase, box, tray, and jar.

$$Entropy_{(shape)} : -\frac{3}{6}\log\frac{3}{6} - \frac{1}{6}\log\frac{1}{6} - \frac{1}{6}\log\frac{1}{6} - \frac{1}{6}\log\frac{1}{6} = 1.79$$

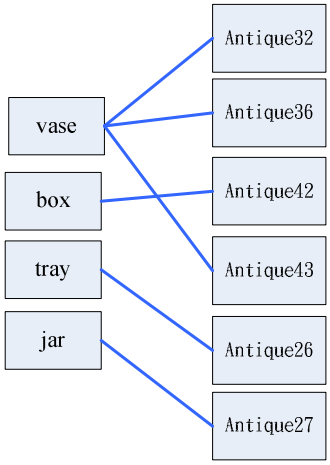

Fig. 4 Entropy of the feature "shape"

About purpose:

There are four feature values in "purpose": decoration, load, flower, and tea.

$$Entropy_{(purpose)} : -\frac{3}{6}\log\frac{3}{6} - \frac{1}{6}\log\frac{1}{6} - \frac{1}{6}\log\frac{1}{6} - \frac{1}{6}\log\frac{1}{6} = 1.79$$

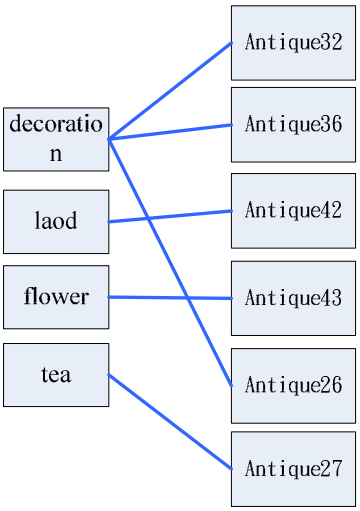

Fig. 5 Entropy of the feature "purpose"

Therefore, the entropy of the pottery at Qing activity is summing of entropy of the feature "shape" and the feature "purpose":

$$Entropy_{(PotteryAtQing)} = 1.79 + 1.79 = 3.58$$

Afterward, system calculates the information about the "pottery at Qing" activity.

$$Info_{(PotteryAtQing)} = Info_{(Qing)} + Info_{(vase)} + Info_{(Qing)} + Info_{(tray)} + Info_{(jar)} + Info_{(decoration)} + Info_{(tea)} + Info_{(load)} + Info_{(flower)} = -1.43 + 1.84 + 2.62 + 5.43 + 4.43 + 3.84 + 3.43 + 3.43 = 26.45$$

In the end, system adds the entropy and information.

$$Difficulty_{(PotteryAtQing)} = 3.58 + 26.45 = 30.03$$

The difficulty value means the degree of difficulty of "pottery at Qing" activity and the activities about the "pottery's dynasty" could get their difficulty values. Eventually system will arrange the order of the activities at series of pottery's dynasty. Then each activity will be appended the suitable activity script template.

Fig. 6 shows the completely order about the series of pottery's dynasty activities. The system will divide the pottery's dynasty activities into two groups by the boundary and positive region. Afterward the process that the system compares with the degrees of difficulty in each activities which are separated to carry out by two groups. This series of activities could be offered Kidd to overcome. When he accomplishes the series of activities, he will be the master about the pottery's dynasty.

4 Architecture

This section we will introduce the complete architecture about the museum game activity generator. The processes about activity generator are separate into the two phases. First phase includes the process I and process II. Second phase includes the process III, process IV and process V. We will introduce the phase I first which is illustrated at Fig 7.

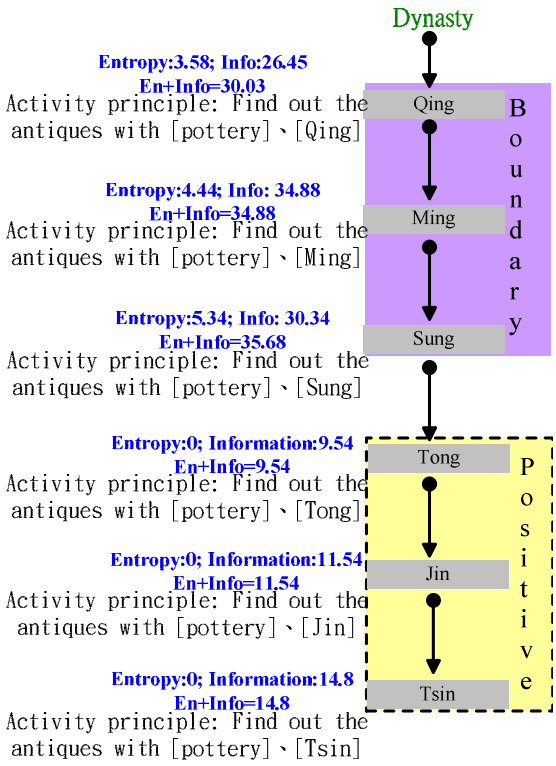

Fig. 6 The series of pottery's dynasty activities

Phase 1: Information preprocess in the Palace Museum

Process I: Analyzing to construct knowledge structure

There are a variety of antiques within the Palace Museum. Hence, we must decide which antiques and characteristics are suitable to be the content of the activities. Then system will discover the characteristics of antiques of knowledge structure by rough set. The context-awareness knowledge structure includes the three parts such like domain, characteristics and objects. In the Fig 7, domain part contains different kinds of domain knowledge within the museum. The characteristic part contains different characteristics of the antiques. The object part represents the antiques within the palace museum.

Process II: Choosing favorite feature

After the system had already constructed the knowledge structure about the antiques in museum, system will offer the features to let users to select. Hence, they can select the interesting feature such as "pottery".

Phase 2: Personalized Activity Generating and practicing

Process III: Generating personalized activities

In the phase 2, there are three processes which must to do. First, in process 3, user had selected an interesting feature. This feature is a topic about whole activities that learner preferences. System will pick out the suitable antiques from context-awareness knowledge structure and it will put these antiques into activity generate engine to get each different series of activities.

At last, the characteristics of each activity will be put into activity script templates to generate the activity principle. An instance is that activity, "pottery at Qing", consists of Qing and pottery. Then system put them into one activity template "Discover the antiques with [material], [dynasty]" to generate the activity principle "Find out the antiques with pottery, Qing".

Process IV: Conquering activity

In this stage, activity generating engine had already produced the whole activities according that user's interest. Then user could choose an activity which he\she is permitted to complete. Each activity has a description to indicate the activity goal. Hence the user must find out the antiques matched the activity goal by observing or touching. When user accomplishes an activity, he will get the permit with next stage activity. Next stage activity is more difficult than former one because of more complexity and less important of the activity content.

Process V: Updating personal experience

In final stage, user has completed four processes about the museum learning game once. Then the personal experience record which is used to store user's learning experience.

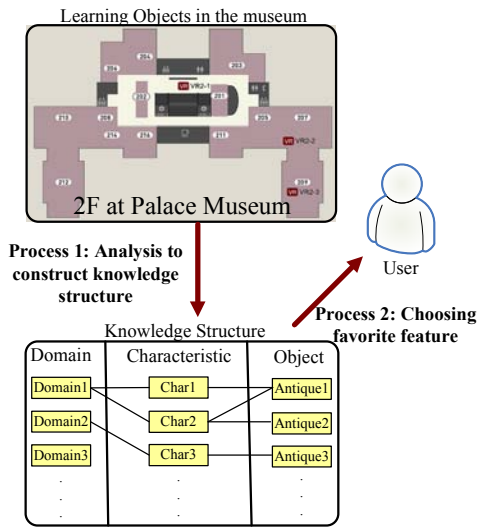

Fig 7 Information preprocess in the Palace Museum

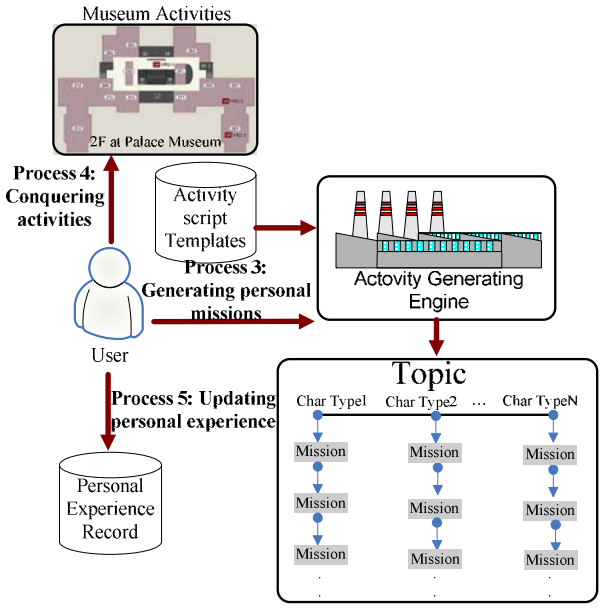

Fig. 8: Phase 2. Personalized Activity Generating and practicing

5 Conclusion

This paper presents an application of museum visit with mobile device. This research provides method which makes museum visit to become a kind of game-based learning. Hence, the game has benefits to motivate kids to learn and improve their learning efficiency. Those benefits coincide our purpose is to let kids visit museum actively. Each activity has different degree of difficulty, different requirement and different antiques. The method we proposed to judge the difficulty of each activity is entropy and information theory. By those designs the museum visiting would be challenging and interesting. Hence the students would like to achieve more activities they can. After students complete a series of activities, it implicates that they had learned a domain knowledge that they interest. In the future, there are some issues we try to research such as designing the branch activities, applying in different domain, making activities to have stories.

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