A Collaborative Ubiquitous Learning Approach to Improving Students' Knowledge for Classifying In-Field Targets

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Abstract

In a ubiquitous learning activity, students are situated in an environment that combines real-world and digital-world learning resources. Although such a learning approach is innovative and interesting, researches have pointed out the problem of lacking proper learning systems that can guide or assist the students to learn collaboratively in such a new learning environment. To cope with this problem, in this study, a collaborative learning platform is developed based on a knowledge engineering approach to supporting collaborative ubiquitous learning activities. Moreover, a learning activity of an elementary school Natural Science course has been conducted with the approach.

1. Background and Motivations

Educators have indicated that students prefer “authentic activities,” in which they can work with problems from the real world (Brown, Collins, & Duguid, 1989). On the other hand, researchers have also indicated the importance of providing learning support seamlessly (Chiou, Tseng, Hwang, & Heller, 2010; Chu, Hwang, Tsai, & Tseng, 2010; Lave, 1991; Hwang & Chang, 2011). Consequently, to situate students in an authentic learning environment, which refers to direct experiences that take place within the context of practice, it is important to place the students in a series of designed lessons that combine both real and virtual learning environments (Minami Morikawa, & Aoyama, 2004). Hwang et al. (2008) further defined the term “context-aware ubiquitous learning”. In such a learning environment, the learner’s situation or the situation of the real-world environment in which the learner is located can be sensed, implying that the system is able to conduct the learning activities in the real world. That is, a context-aware u-learning environment is able to offer more adaptive supports to the learners by taking into account their learning behaviors and contexts in both the cyber world and the real world; moreover, the learning system can actively provide personalized supports or hints to the learners in the right way, in the right place, and at the right time, based on the personal and environmental contexts in the real world, as well as the profile and learning portfolio of the learner (Chu, Hwang, & Tsai, 2010; Chu, Hwang, & Tseng, 2010; Hung, Lin, & Hwang, 2010; Shih, Chuang, & Hwang, 2010).

However, without proper learning support, students might feel confused in such an “active”, “authentic”, “constructive” and “collaborative” learning environment. Among various technologies, computer-oriented Mindtools have been recognized as being an effective way for training the “meaningful learning” and “critical thinking” abilities of students. Jonassen (1999) further indicated that, the creation of the knowledge bases of expert systems is the part of the activity that engages critical thinking; that is, students are likely to interpret and organize their personal knowledge while participating in the knowledge acquisition process, which has been called *knowledge engineering*. Therefore, it has become an important issue to develop Mindtools using the knowledge engineering approach. Researchers also indicated that the critical bottleneck of building expert systems is to obtain the knowledge of the special domain from the domain experts, which is called *knowledge acquisition*; The most widely used knowledge acquisition technology is the grid-based approach (Edwards, McDonald, & Young, 2009; Hwang, Lin, Tseng, & Lin, 2005, 2006; Jankowicz, 2004).

In the past decades, several models have been proposed to generate more meaningful rules based on the grid-oriented approaches, such as the EMCUD method, which can generate embedded meanings from a grid-based knowledge representation format by defining the impacts of the constructs on each element (Hwang & Tseng, 1990; Hwang, Chen, Hwang, & Chu, 2005;

Hwang, Chen, Hwang, & Chu, 2006). Chu and Hwang (2008) proposed a Delphi-based approach to eliciting knowledge from multiple experts with a grid-based approach originated from the method proposed by Kelly (1955), and applied it to a medical category. It can be seen that researchers not only consider gathering individuals' knowledge, but also concentrate on reaching the common consensus of a group. More precisely, it is aimed to offer chances to group members to refer to other members' knowledge and enhance or share one's own knowledge.

2. Grid-oriented Platform for Collaborative u-Learning

In the collaborative u-learning activity, the students need to determine the constructs for describing and classifying the target elements by themselves. Moreover, they need to fill in each <construct, element> relationship with a description instead of a rating. The teachers need to provide the objective repertory grid, which will be served as the scaffolding for the students (Hwang, Chu, Lin, & Tsai, 2011).

The collaborative u-learning activity consists of three phases (as shown in Figure 1):

(1) In the first phase, the students are guided to observe the learning objectives in the authentic environment. They compose new knowledge via building the grid to describe the attributes of the learning objects and the relationships among them. Students are allowed to interact with their peers in this phase. After the students complete their own grid, the teacher integrates the grids developed by individual students and grades the importance degree for each construct.

(2) In the second phase, the students are allowed to refer to the integrated grid, and modify their own grid in computer classroom. That is, students are allowed to incorporate new ideas (constructs) by discussing with their peers and visiting the integrated knowledge grid.

(3) In the third phase, the students will be asked to observe the learning objectives in the authentic environment again, to modify their own grid.

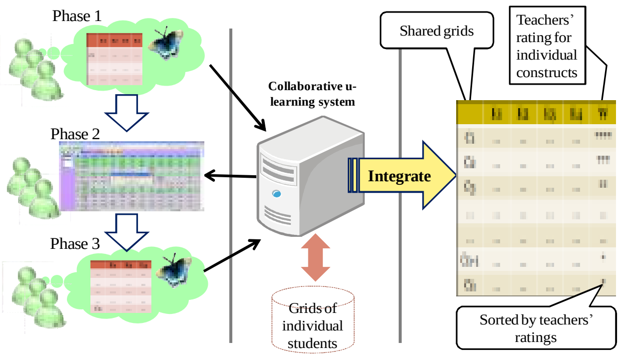

Figure 1. The three phases of the collaborative u-learning activity

Based on the innovative approach, the PCUL (Platform for Collaborative U-Learning) system has been developed to assist the students in identifying and classifying learning objects observed in the real world. Figure 2 shows the structure of the collaborative learning environment. By following the instruction displayed on the PDA, the student can find the exact location of the target butterfly, and start to observe its characteristics of it. After finishing the observation of the butterfly, the student will be guided by PCUL to find another target butterfly in the butterfly ecology garden and compare the two. Meanwhile, the student is asked to find a construct for distinguishing the butterflies and write it on the PDA.

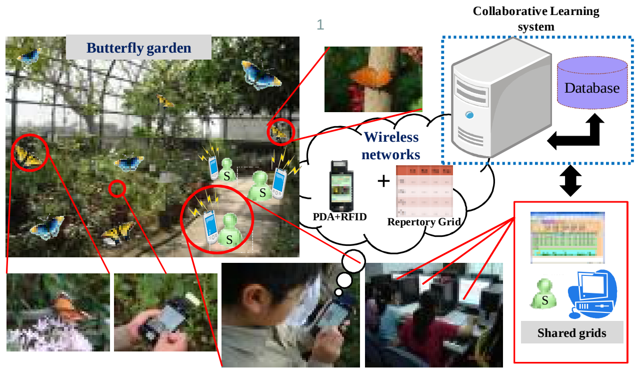

Figure 2 Structure of the collaborative learning environment.

While observing butterflies in the ecology garden, the students are guided by PCUL based on their on-going grids. As shown in Figure 3, PCUL will assist the students to give a construct by using that to distinguish the two objects. Once the student define the construct, they will be asked to complete their grids by observing the learning objects with empty <learning object, construct> value.

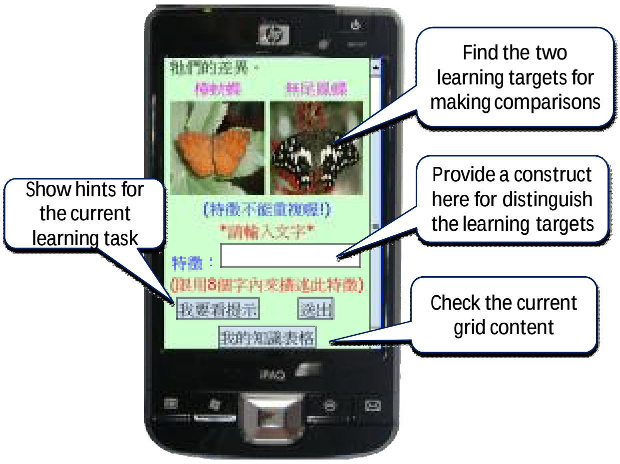

Figure 3. Illustrative example of guiding the students to observe the butterflies and defining a construct

After defining all the constructs, the students are asked to complete the learning results in their grid (as shown in Figure 4).

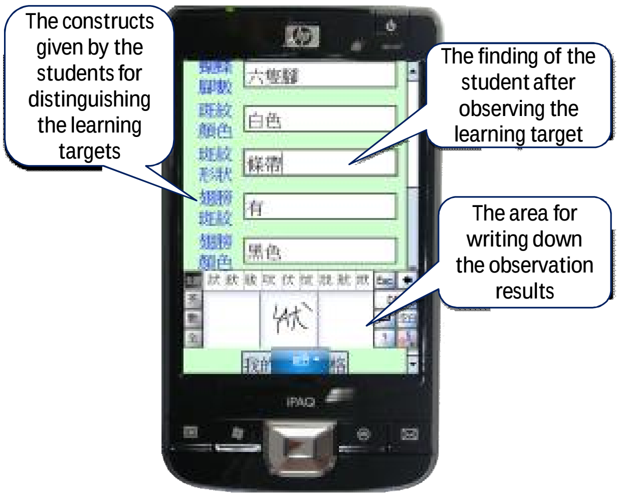

Figure 4. Illustrative example of guiding the student to record the observation results

In the second phase, the students are asked to refer to the integrated grid and modify their own grids in the computer room. To offer high quality reference materials, the experts are asked to grade the grids and the constructs developed by the students before starting the knowledge-sharing activity. In addition, all of the constructs provided by the students are sorted by the experts from the most important to the least important. When the students log in PCUL in computer room, an interface is provided to show the grids developed by individual students in the first phase, as shown in Figure 5. In this interface, all of the grids are displayed with a grade from five stars (excellent) to zero star (poor). After referring to the graded grids, the students are allowed to modify their own grids.

Figure 5. Interface of PCUL for browsing the grids developed by individual students

3. Experiment and Analysis

To evaluate the efficacy of the PCUL system, an experiment was conducted on the "Butterfly and Ecology" unit of the natural science course of an elementary school in Taiwan. The authentic learning environment is a "Butterfly and Ecology" garden in an elementary school. The butterfly ecology garden is divided into 11 ecology areas according to the specific host plants; moreover, each area has an instructional sign to introduce the butterflies in that area. Note that each species of butterfly requires special host plants as their foods; therefore, in each ecology area, the students are able to observe the ecology of the butterflies that have special relevance to the host plants of that area. The participants of this study were 21 fifth-grade students.

This study investigated the improvements of the students' field classification ability by evaluating the repertory grids developed during the learning process. Researchers have indicated that the quality of the classification ability represented in a repertory grid highly depends on two factors: first, the constructs (i.e., characteristics) used for identifying and classifying the elements (i.e., butterflies); second, the ratings given to describe the relationships between the constructs and the elements (Shaw, Turvey & Mace, 1982; Chu & Hwang, 2008).

In this study, the learning activity consisted of three phases. In the first phase, the students were guided to observe the learning objects in the butterfly garden and to develop their own repertory grids. In the second phase, the students were asked to share their repertory grids with others. In the third phase, the students were asked to observe the learning objects in the butterfly garden again, and modify their repertory grids according to their observations.

The repertory grids developed in each phase were evaluated by two experienced teachers based on the suitability of selecting the constructs for classifying the butterflies and the correctness of the ratings for describing the <butterfly, characteristic> relationships. By applying the Pearson correlation analysis, it was found that the scores given by the two experts were highly consistent, with a correlation coefficient of 0.81 ($p < .01$).

The paired-samples t-test result for the scores of the repertory grids developed by the students in the first and third phases indicates that the students have made significant improvements after participating in the collaborative u-learning activity, as shown in Table 1.

Table 1. Paired-samples *t*-test of the scores of the grids developed in the first and third phases

	Mean	N	SD	M.D.	*t*
The grid scores in the first phase	28.50	21	14.73	-48.12	-9.81^{***}
The grid scores in the third phase	76.62	21	28.14		

$^{***}p < .001$; M.D. Mean difference

4. Conclusions

In this paper, a collaborative u-learning approach is presented. The experiment result shows that the innovative approach is helpful to the students in improving their knowledge for differentiating the real-world learning targets.

In the future, we plan to employ this approach to more u-learning activities. Moreover, it is expected that more measuring tools can be used to evaluate the students' learning performance from different aspects, such as learning achievements, attitudes, and self efficacy.

Acknowledgments

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