An Innovative Learning Model that Integrate Digital Contents and Real World Contexts

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Learning in the In-Class age

- Mass education
- Print technology
- Textbook
- Learning as knowledge transmission

Learning in the computer/Internet age

- Individualised learning
- Computer technology
- Virtual learning environment
- Learning as knowledge construction

Learning in the mobile/ubiquitous age

- Mobile learning
- Handheld wireless technology
- Virtual+Real learning environment
- Learning as conversation in context

Mobile Technologies

- Wearable devices
  - Watch, GPS, organiser, music player, thermometer, barometer
- Mobile phones
  - Phone, music player, camera, organiser, games
- Handheld computers
  - Organiser, wireless web, email, video, messenger, games
- Pen tablet computers
  - Multimedia computer, notepad
- Laptop computers

Features of Mobile/Ubiquitous Learning

- Learner centred
- Individualised
- Collaborative
- Situated
- Ubiquitous
- Lifelong

Mobile/Ubiquitous Learning Strategies

Situated learning

- Learning is a process of social participation
- Knowledge should be presented in authentic contexts
- Learners participate within a community of practice
- Problem-based (or enquiry-based) learning
  - Explore problems rather than test mastery of skills
  - Students refine and examine problems and develop solutions
  - Assessment is authentic and performance based

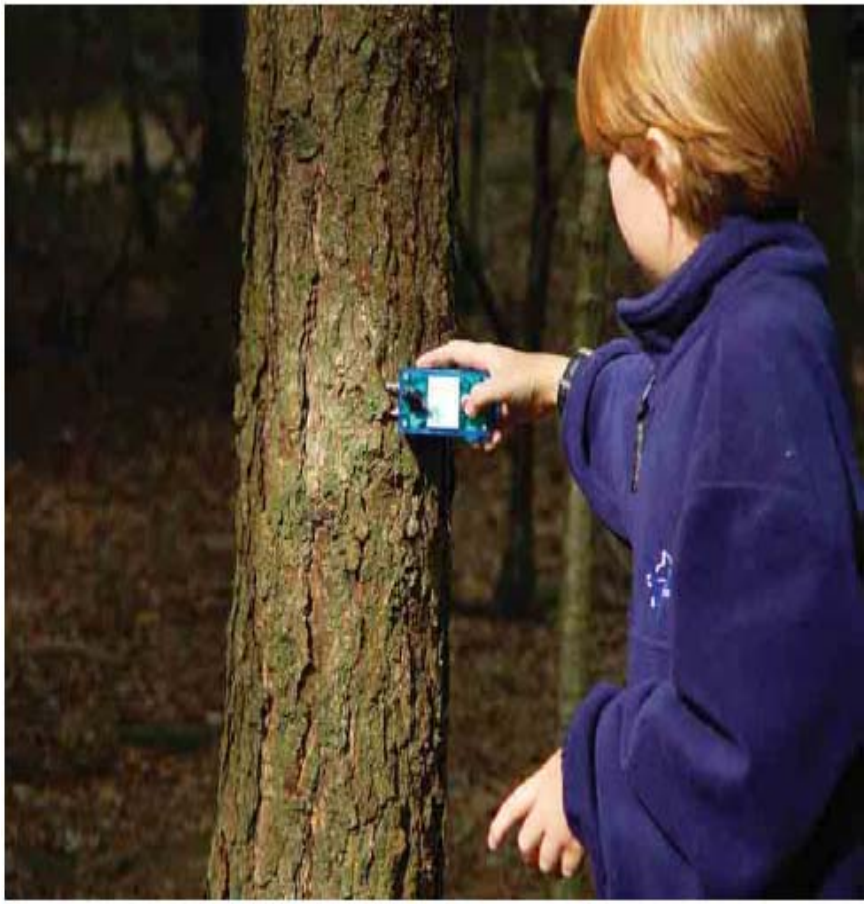
The Ambient Wood Project

- Learning experience was designed that encouraged children to explore and hypothesize about different habitats (棲息地) found in a woodland.
- Mobile devices was provided for the children to access and share contextually relevant digital information when indoors and outdoors.

The Ambient Wood Project

- It was designed to enable children
  - to switch from their experiences of the **physical world** (e.g. observing a butterfly drinking nectar (花蜜) from a thistle (薊類植物)
  - to reflect upon the **ecological processes** that lie behind this interdependency, eg. pollination(授粉)

Probe tool



- designed to enable children to collect real-time measurements of light and moisture in the area
- PDA display as dynamic visualizations
- stored all the readings and the location

Ambient horn (無線驅動式聽筒)

- a handheld device the children held to their ears to hear the sounds
- triggered via location pingers, according to the children's location, but was under the children's control.

Wireless speakers (隱藏式擴音器)

- hidden in sections of the woods
- realistic sounds of animals in the habitat and abstract sounds that represented various plant processes

Visualization tools

- enable students to reflect upon their outdoor discoveries in indoor settings
- reconstruct what they had seen, collected, and heard

Mixed-Reality Learning
MyArtSpace project

- Aim: to make school museum visits more engaging and educational
- Combines
  - personal space (mobile phones)
  - physical space (museum, classroom)
  - virtual space (online store and gallery)

Mixed-Reality Learning
MyArtSpace project

- Children as curators, create their own interpretations
- They use mobile phones to collect content, take photos, make recordings, share notes
- They create, share and publish their own online collections
- Full-scale deployment in test sites over one year

Ubiquitous Computing & Context-Aware Technologies

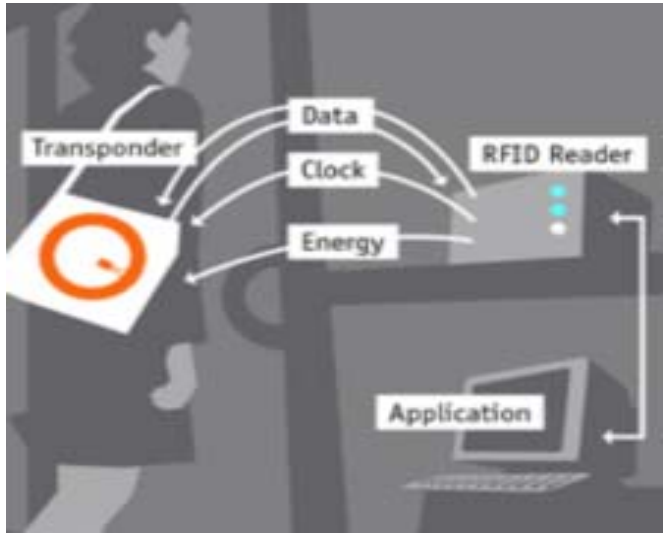
Ubiquitous Computing (u-computing) Technologies

- Proposed by Mark Weiser in 1988
- Small computers are embedded in the articles for daily use, which are able to sense human behaviors and make reactions.
- It is also called the “Calm Technology”.

Features of u-computing

- Computing with Natural Interfaces
- Context Aware Computing
- Automated Capture and Access to Live Experience
- Everyday Computing
- Social Implication and Evaluation

Context Aware Computing



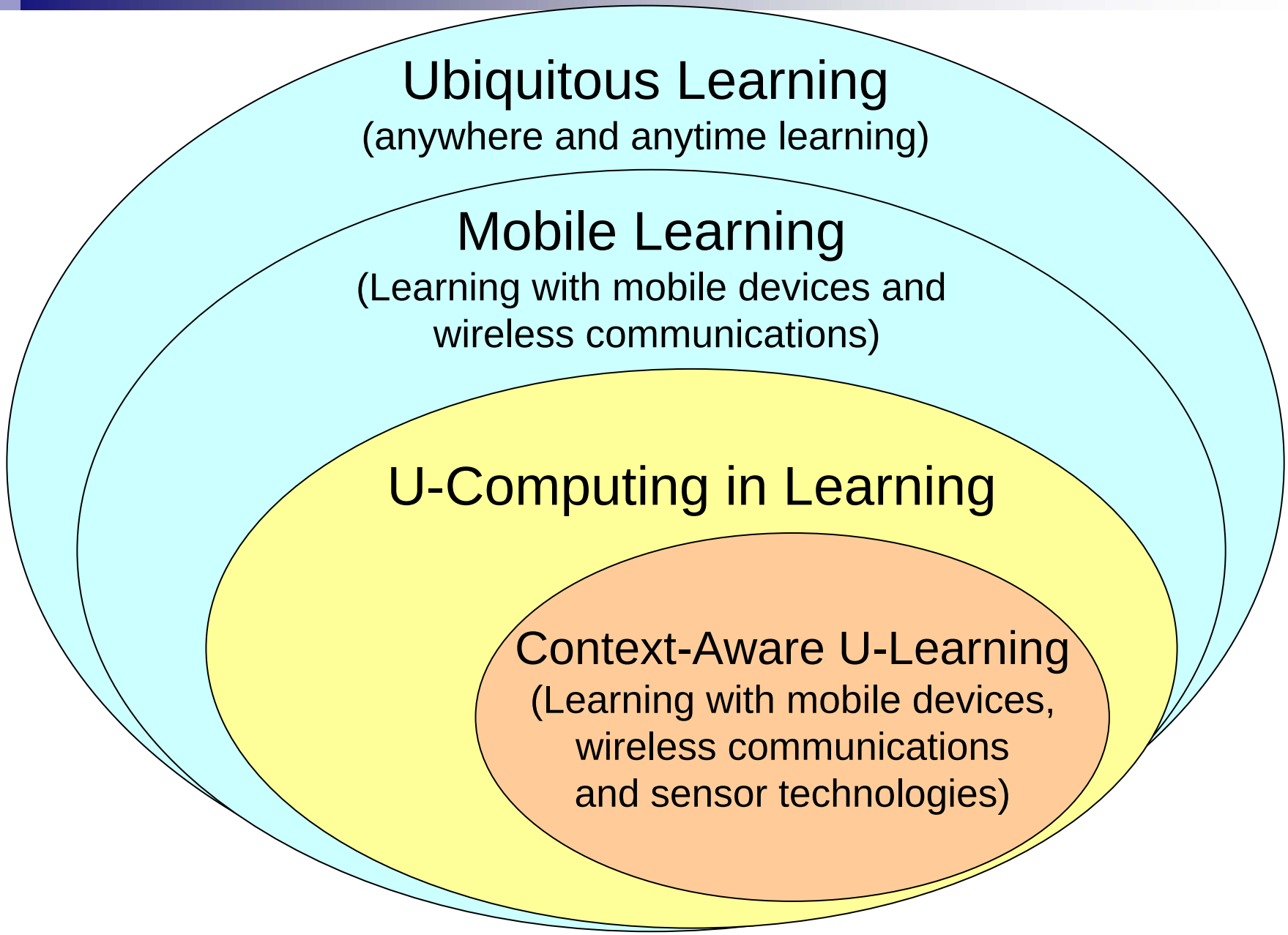
- minimal set of necessary context:
  - *Who* : User and other people in the environment.
  - *When* : User activity relative changes in time.
  - *Where* : The physical location of the user.
  - *What* : Interpretations of user activity.
  - *Why* : Understanding the activity of the user.

Automated Capture and Access to Live Experiences

- Not only trying to remember the important pieces of information
- Tools to support automated capture and access to live experiences
- Remove the burden of doing something humans are not good at (i.e., recording) so that they can focus attention on activities they are good at (i.e., indicating relationships, summarizing, and interpreting).

Everyday Computing

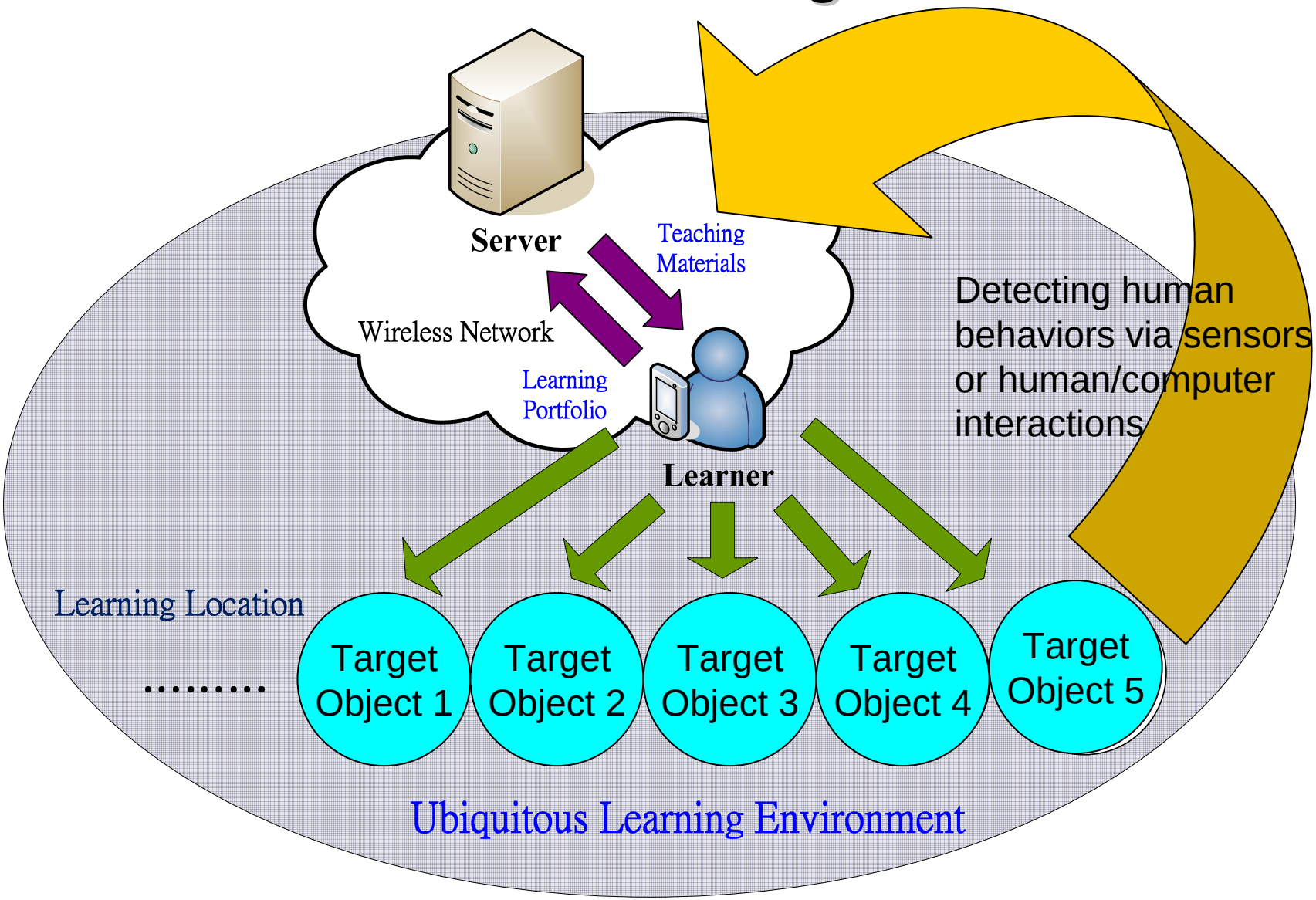
- Support the informal and unstructured activities of our everyday lives.
- Providing *continuous* interaction moves computing from a localized tool to a constant presence.


Ubiquitous Learning
(anywhere and anytime learning)
Mobile Learning
(Learning with mobile devices and
wireless communications)
U-Computing in Learning
Context-Aware U-Learning
(Learning with mobile devices,
wireless communications
and sensor technologies)

How u-computing technologies benefit learning activities?

- A u-computing environment is able to sense personal behaviors in the real world
  - It is able to provide more information to support adaptive learning
  - It is able to guide the learner in the real world
  - It is able to judge the learner's behaviors in the real world is correct
  - It is able to more actively provide necessary information to the learner

Context-Aware U-Learning Environment



Examples of Context-Aware U-Learning

Ogata & Yano(2004)	建置JAPELAS和TANGO兩套系統，以支援語言學習的U-Learning環境
Rogers et al.(2005)	藉由U-Learning整合室內(indoor)及室外(outdoor)森林實地考察的學習經驗
Hwang et al.(2006)	以U-Learning概念規劃並建置一套單晶X光繞射研究人員訓專家系統
Joiner et al.(2006)	以聲境技術 (SoundScape Technology)設計情境教育的探索

Four steps of providing context-aware u-learning system services

- Setting instructional requirements for each of the learner’s learning actions
- Detecting the learner's behaviors
- Comparing the requirements with the corresponding learning behaviors
- Providing personal support to the learner

Context-Aware u-learning vs M/U-Learning

M/U-Learning	Context-Aware U-Learning
understands the learner's situation by accessing the on-line database.	In addition to access the on-line database, it is able to sense the learner's situation in the real world.
Learners need to actively access the system via wireless networks.	System can more actively provide personalized information or services to the learners based on real world context
Learning portfolio records the on-line behaviors of the learner.	System can record the real world information of the learner.

More parameters in a context-aware u-learning portfolio

- **Personal situation in the real world**: learner's location, time of arrival, temperature, heartbeat, blood pressure, etc.
- **Environmental situation** : the sensor's ID and location, the temperature, humidity, air ingredients, and other parameters of the environment around the sensor
- **Feedback from the sensor** : the sensed values of the target, e.g. PH value of water.
- **Personal data in the database** : learner's profile and learning portfolio, such as the predefined schedule, starting time of a learning activity, the longest and shortest acceptable time period, place, learning sequences.
- **Environmental data in the database** : equipment in the lab, the rules of using the lab, the time table of using the lab

More Intelligent Tutoring & More Adaptive Learning with u-computing

Problem Solving Support

- Main duty and main value of ITS technology
- Three technologies
  - (1) Intelligent analysis of student solutions
  - (2) Interactive problem solving support
  - (3) Example-based problem solving support

E/M to U: Problems solving scenery moves from virtual world to real world

(1) Intelligent analysis of student solutions

- deals with students' final answers
- decide whether the solution is correct or not
- find out what exactly is wrong or incomplete
- identify which missing or incorrect knowledge may be responsible for the error (knowledge diagnosis)
- provide student with extensive error feedback and update the student model. Eg, PROUST (Johnson, 1986)

E/M to U: **Problems solving scenery** moves from virtual world to **real world**

(2) Interactive problem solving support

- provide intelligent help on each step of problem solving Instead of waiting for the final solution
- The levels of help vary from signaling about a wrong step, to giving a hint, to executing the next step for the student
- The systems (often referred to as *interactive tutors*) can watch the actions of the student, understand them, and use this understanding to provide help and to update the student model.

E/M to U: Problems solving scenery moves from virtual world to **real world**

(3) Example-based problem solving support

- helping students to solve new problems by suggesting them relevant successful problem solving **cases** from their earlier experience
  - eg: ELM-PE (Weber, 1996), ELM-ART (Brusilovsky, 1996) and ELM-ART-II (Weber, 1999)

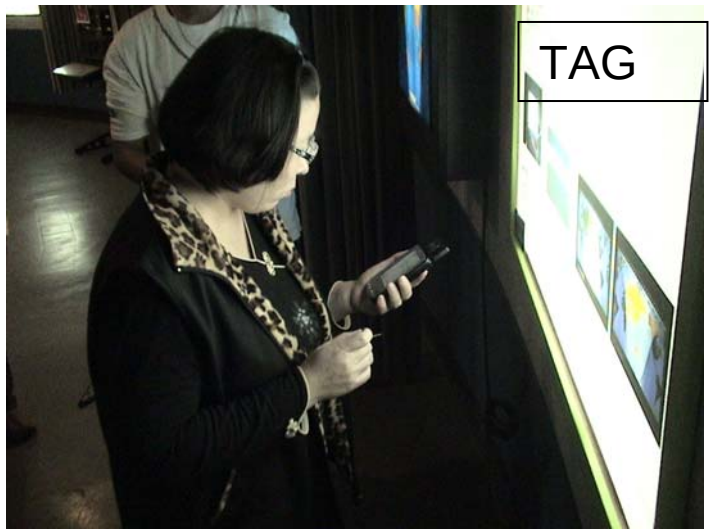
E/M to U: Problems solving scenery moves from virtual world to **real world**

Minimal Requirements for building a context-aware u-learning environment?

- A set of readers (or sensors) that sense the situation (at least location) of the learner (e.g., RFID readers)
- A set of tags that can be used to identify each learner
- A server that can access the user's situation from the readers
- A mobile device that can display the messages from the server

RFID (Radio Frequency Identification) - an available sensor

- An RFID system consists of a set of Tags and Readers.
- Each Reader is connected to a mobile device.



When should the context-aware technology be applied?

- Do the learners need supports from the system?
- Do we need personalized instructions?
- Do the instructions or supports need to be given actively?
- Do the learners need to move from places to places during the learning process?
- Do the learners need to learn in the real world?
- Does the context (e.g. location or environmental temperature) of the learner affect the learning process?

Case studies on Natural Science courses

- Observation and classification skills are two important goals of learning.
- **A mobile learning environment** with **context-aware approach** for training observation and classification skills of elementary school students.
- Cases studies have been conducted on the **“butterfly and ecology” subject unit** of a natural science course.

Background and Motivations

In conventional approach, a teacher usually needs to train the observation and classification skills of 10 or more students in the same time.

Background and Motivations

It is difficult to provide personalized instructions and to record the learning portfolios.

Table 1: Digital contents in the electronic library

	E1  (Byasa Impediens)	E2  (Byasa Alcinous)	E3  (Pachliopta Aristolochiae)	E4  (Byasa Polyeuctes)	
large size	2	2	2	1	small size
spots in fore-wings	5	5	5	5	no spot in fore-wings
single spot type in back-wings	1	1	4	4	multiple spot type in back-wings
complex wing pattern	5	5	4	4	simple wing pattern
big spots	3	5	1	3	small spots
Big raised tail in back-wings	1	1	1	1	Small raised tail in back-wings
Long and thin raised tail in back-wings	4	4	4	4	Short and fat raised tail in back-wings
red spots in raised tail of back-wings	5	5	5	1	No red spot in raised tail of back-wings

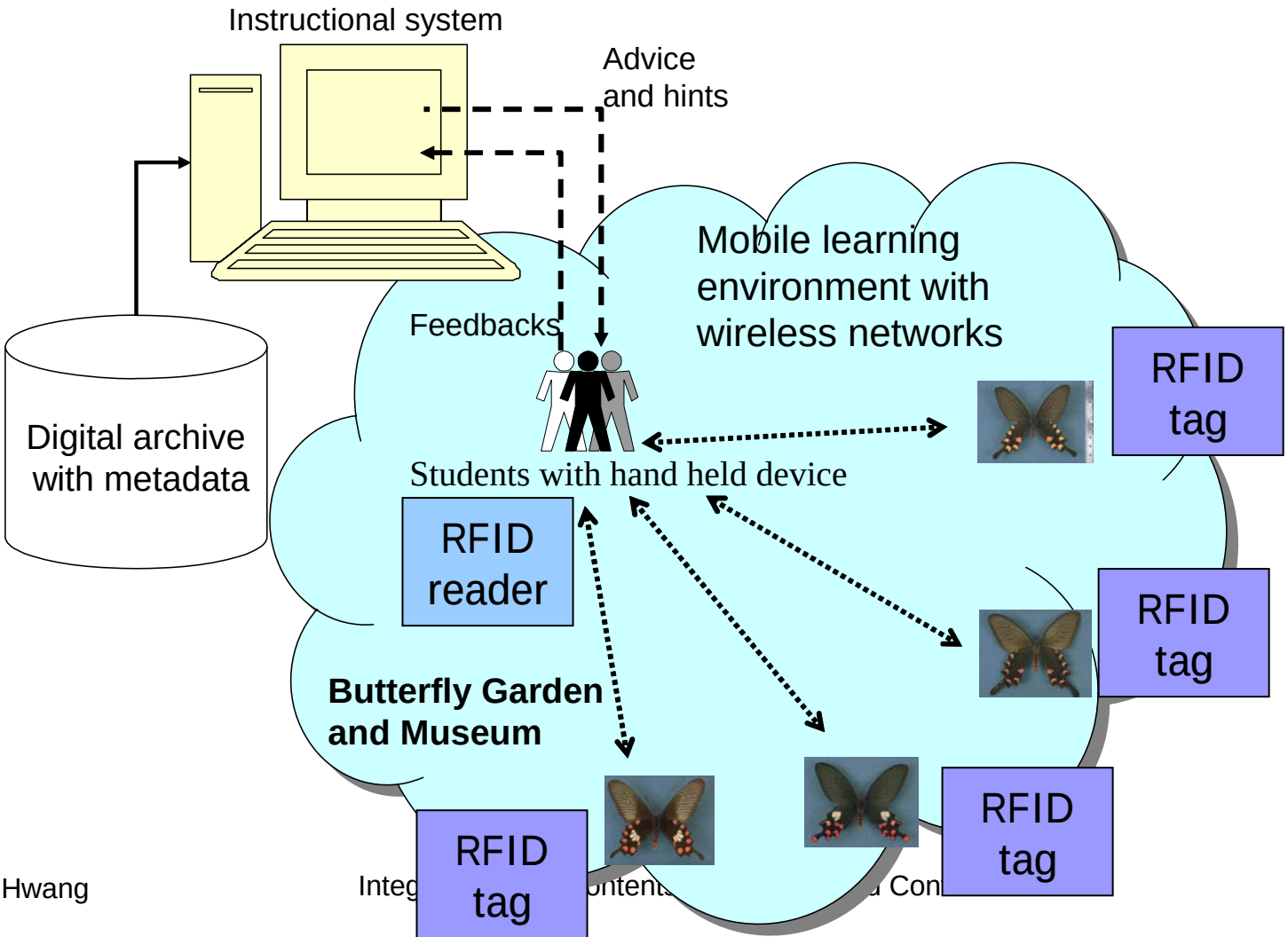
Acquisition of Observation and Classification Skills

- Appropriate assistance or hints are helpful to the students in improving their learning status while encountering problems during the learning process.
- The ratings of the repertory grid can be used to forecast the possible misconceptions while the student failed to recognize an object.

Instructional example of the mobile learning system

- Assume that the e-learning system asked the student to recognize E4 (Byasa Polyeuctes); however, the student made an erroneous judgment by taking E3 (Pachliopta Aristolochiae) as the answer.
- The mobile learning system will retrieve the repertory grid data from the e-library, and find the **most significant feature** that can be used to distinguish E4(Byasa Polyeuctes) and E3(Pachliopta Aristolochia).

Structure of the mobile learning environment



Butterfly museum

Students are asked to follow the instructions displayed on PDA to observe and classify various types of butterflies based on the characteristics.

Location of the butterfly to be recognized

The most significant feature of the butterfly

Knowledge base management

Illustrative example of conducting mobile learning with E-Butterfly

Evaluation

- Two teachers were asked to experience the learning environment.
- Teacher A (TA) had five-year experience of conducting the butterfly course.
- Teacher B (TB) had eleven-year experience.

Independent semi-structure interviews questions

- The interview questions mainly explored researchers' responses and suggestions to the mobile learning environment.
- Considering **"personalized"** and **"effective"** to be the remarkable benefits for the mobile learning environment.

Opinions from the Teachers

- Focus on "**personalized**" viewpoints:
  - "Unlike traditional training process by human, the mobile learning system is much more organized, because the PDA will remind you of every detailed thing clearly and specifically."
  - "The learner can go over the learning sequence repeatedly with the PDA instead of asking the same questions to the teachers."
- The **personalized learning function** could increase the **learning efficiency**

Opinions from the Teachers

- Focus on "**recording function**" viewpoints:
  - "With this innovative system, we can see the learning process of individual students. This would make the learners more serious while working with the equipment."
- The mobile computing technological system was **user-friendly**.
  - "The PDA will remind me of the sequence step by step, and this makes me have less pressure while learning."

Evaluation and Conclusions

- As to the "**effective**" perspectives, the teachers showed the same position on the use of the repertory grid.
- How the learning guidance function worked?
  - Both of teachers expressed positive perspectives for the "correctness" and "effectiveness".
- They believe that the learning environment with the innovative approach has the potential to motivate learners to learn more willingly.

Work in Progress

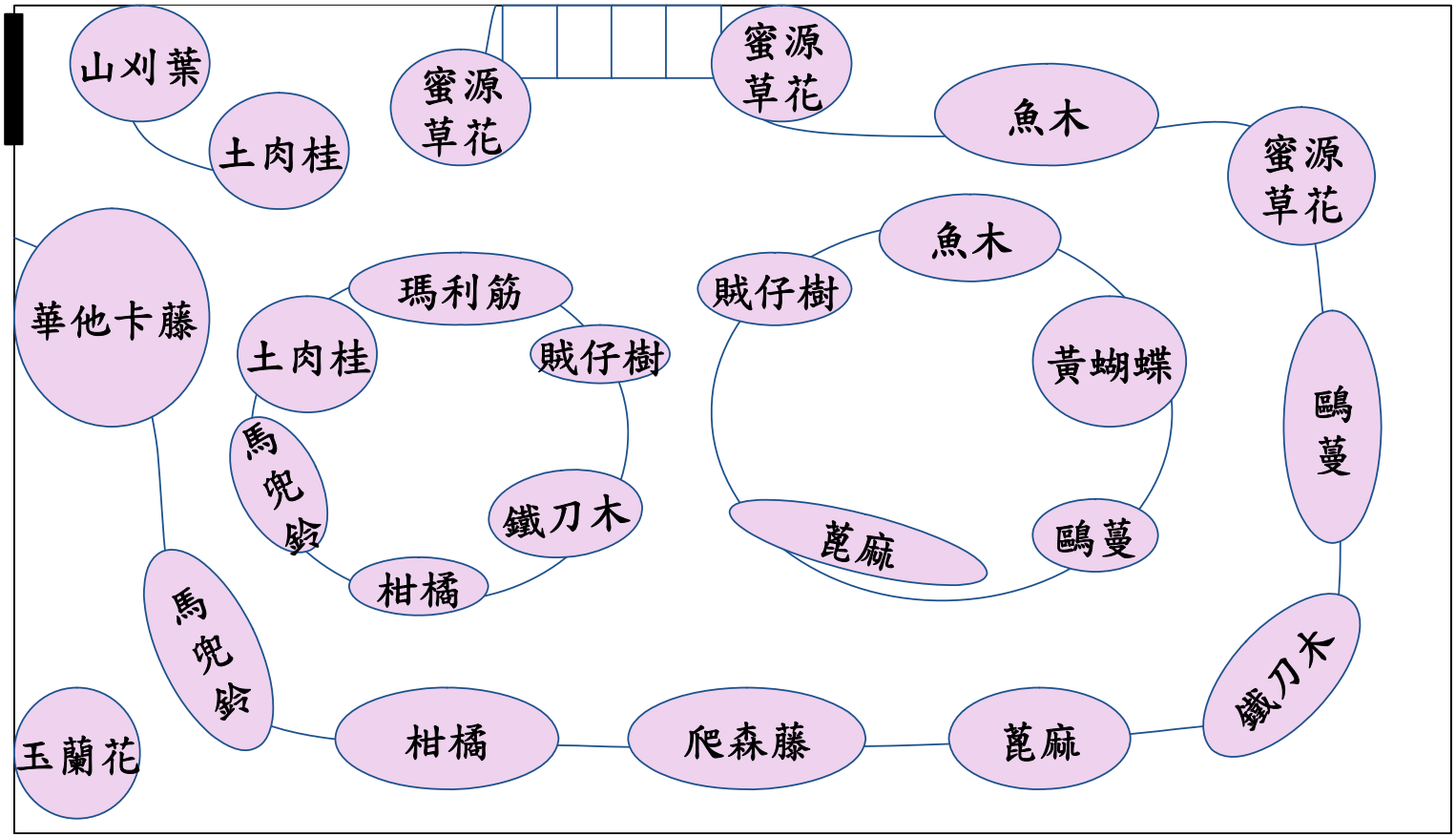
- Currently, an experiment is being conducted on k-5 students to evaluate the effectiveness of our approach.

Work in Progress

- Developing new subject units for training the observation skills in the Butterfly Ecology Garden.

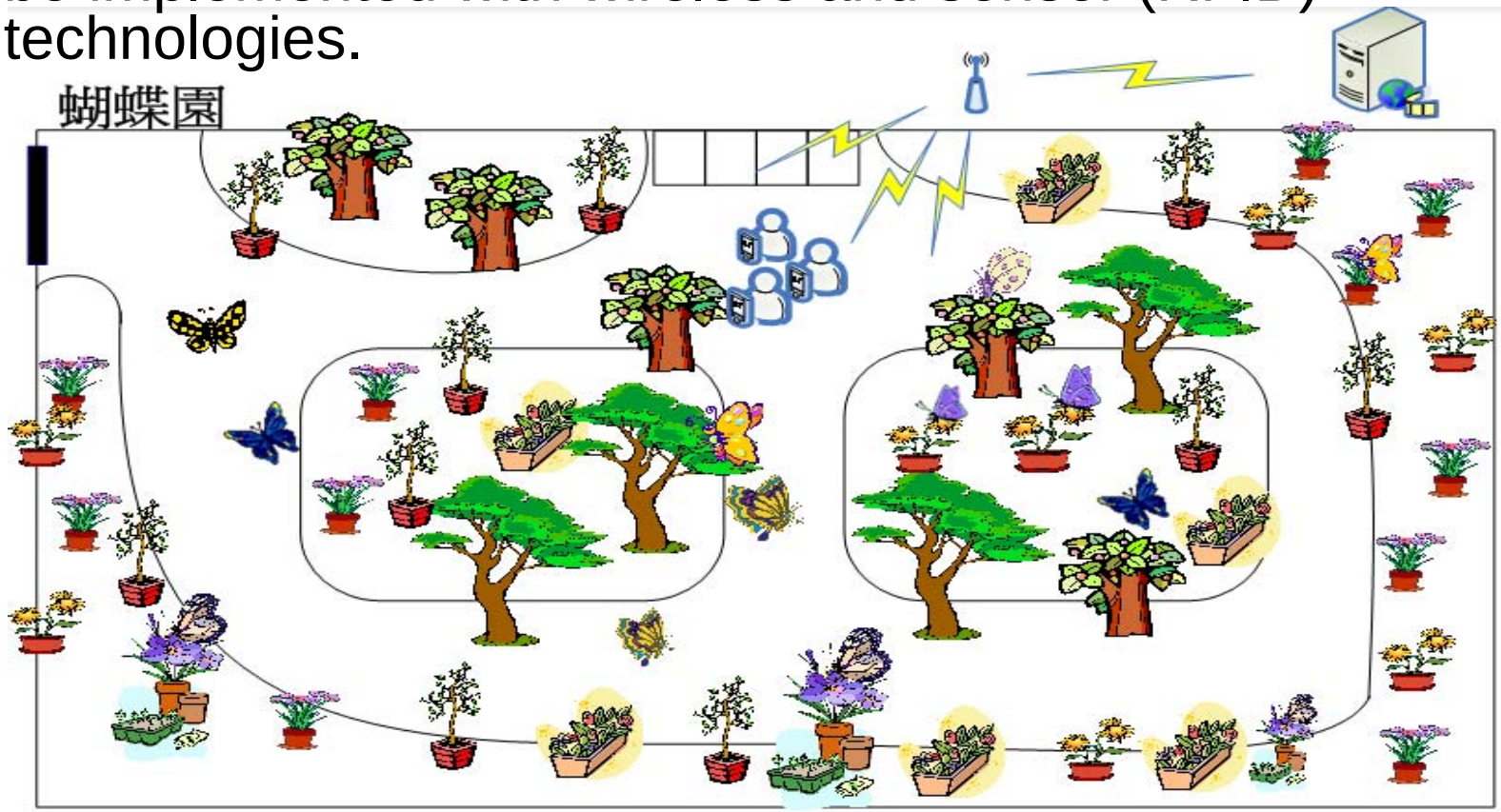
Work in Progress

- The Butterfly Ecology Garden consists of 25 ecology areas.



Work in Progress

- An instructional system and an assessment system will be implemented with wireless and sensor (RFID) technologies.



Conclusions

- The advance of sensor and wireless communication technologies has brought people a new the way of education.
- In the new learning environment, digital contents and real world contexts can be integrated.
- New learning activities and tutoring strategies can be proceeded.

Thank You!!