Mobile Learning Research in Specific Disciplines

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http://www.idlslab.net/
IDLS (Intelligent Distance Learning Systems) lab

- Funded by MOST and MOE of Taiwan per year for conducting mobile learning programs
  - Science courses
  - Social studies courses
  - Computer courses
  - Language courses
  - Nursing courses
  - Computer or engineering courses
The backgrounds of the members in this lab include Computer Science and Educational Technology.
Mobile learning community in Taiwan

- Researchers from 10 universities in Taiwan
- Sharing research experiences and results every 6 months
International research cooperation

- Japan: Prof. Sachio Hirokawa’s team and Prof. Hiroaki Ogata’s team in Kyushu University
- Sweden: Prof. Marcelo Milrad’s team in Linnaeus University
- Canada: Prof. Kinshuk’s team in Athapasca University
- China: Faculty of Education, Beijing Normal University
- Thailand: Innovative Learning Center of Mahidol University
- Hong Kong: The Education University of Hong Kong
Academic Publications of IDLS Lab

- 200+ journal papers
  - Computers & Education (SSCI)
  - Educational Technology & Society (SSCI)
  - Interactive Learning Environments (SSCI)
  - British Journal of Educational Technology (SSCI)
  - Australasian Journal of Educational Technology (SSCI)
  - Innovations in Teaching and Education International (SSCI)
  - Electronic Library (SSCI)
  - IEEE Transactions on Education (SCI)
  - IEEE Transactions on Learning Technology (SSCI)
  - IEEE Transactions on SMC, Part C (SCI)
  - IEEE Transactions on Mobile Computing (SCI)
  - Expert Systems with Applications (SCI)
  - Other SCI/EI/TSSCI journals

- 300+ papers presented in conferences
- 10 book chapters (in English)
- 4 e-learning books (in Chinese)
Mobile and ubiquitous learning

**M-Learning**
- A kind of learning using mobile technologies to facilitate students to learn
- enabling students to learn across contexts
- emphasizing the use of mobile technologies or the mobility of students in the learning process.

**U-Learning**
- emphasizing “learning can be proceeded at any place and in any time.”

**M-learning** is a way to achieve the aim of u-learning (via using mobile technologies).
M-learning/u-learning with sensing technologies

- Some researchers have tried to conduct m/u-learning activities with sensing technologies (e.g., GPS, RFID, and QR-codes).
- **Context-aware ubiquitous/mobile learning** - the approach that uses mobile, wireless communication and sensing technologies to support real-world learning activities (Hwang, Tsai, & Yang, 2008)

Ubiquitous Learning
(anywhere and anytime learning)

Mobile Learning
(the use of mobile and wireless communication technologies in learning)

Context-Aware U/M-Learning
(Learning with mobile, wireless communications and sensing technologies)

Objectives of conducting mobile/ubiquitous learning activities

- Link what students’ learning from the textbook to what they have experienced in the real world (or daily life)
- Provide guidance or support to individual students for dealing with real-world problems
- Enable students to learn across contexts (seamless learning)
Example of a context-aware u/m-learning environment using RFID/QR-code

The learning system is executed on the server.

Each student has a mobile device equipped with an RFID or QR-code reader as well as the wireless communication facility.

Each learning target (e.g., a plant, an area, or an object) has an RFID/QR-code tag on it.

Once the student walks close to a learning target, the RFID/QR-code reader can receive the information from the corresponding tag.
Benefits of using sensing technologies (e.g., GPS, QR-code, RFID)

- The learning system is able to guide the students in the real world via detecting their locations.
- The learning system can more actively provide learning supports (e.g., hints, warnings or supplementary materials) to the learners if necessary.
  - Warn the students before something goes wrong in a dangerous chemical experiment.
More parameters can be recorded with the help of sensing technologies

- **Personal context in the real world**: learner’s location, time of arrival, body temperature, heartbeat, blood pressure, etc.

- **Environmental context**: the learning target’s ID and location, the environmental temperature, humidity, air ingredients, and other parameters of the environment around the sensor.

- **The data collected by the students in fields**: 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 equipment, the time table of using the lab.
Early m/u-learning studies -Serving as a Tutor or Guide in the field

The m/u-learning systems serve as a personalized tutor to guide the students to learn or practice in the real world.
The aim of the study is to foster students the competence of applying integrated knowledge with clinical skills to the application domains.

In the traditional approach, in-class knowledge learning and clinical skills training are usually conducted separately.

- the students might not be able to integrate the knowledge and the skills in performing standard nursing procedures.
Context-aware mobile learning system for training physical assessment skills

- The learning system guides the students to observe the dummy patient and collect data following the standard process of physical assessment.

- Degree of mastery (DM) (Barsuk, Ahya, Cohen, McGaghie, & Wayne, 2009; Block, 1971; Carroll, 1963):

\[
DM(Si) = \frac{(\text{expected completion time})}{(\text{student completion time})} \times 100\%
\]
Mastery Learning

- Originated from Model of School Learning proposed by Carroll (1963).
  - Main principle: When students have proper opportunity to learn, they will learn.
- Bloom (1968) revised “proper opportunity” to “students need to master every bit of knowledge of every learning goal to move on to the next one.”
When the students approach a dummy patient, the RFID reader on the mobile device detects the tag on the patient and provides relevant information, including the patient's name, symptoms and case history.
context-aware mobile learning environment for training nursing skills

Students use mobile device with RFID reader to detect physical symptoms of the dummy patient.
detecting pathological (病理) signs from the dummy patient

The student collects and assesses the life sign of this body part.

Information of life sign:
(1) blood pressure: 176/98 mmHg
(2) temperature: 39 ℃
(3) pulse: 110 times/min
giving hints for mistakes or missing steps.

Please collect palpation information of the chest.
The position is incorrect. Please think about it again.
Your steps:
(1) Upper part of left clavicle
(2) lower part of left clavicle

The system provides the correct steps for palpation of the chest.
(1) Superficial palpation
(2) Thoracic expansion
(3) Tactile fremitus
The final step of the standard operating process: examine the patient’s blood test report.

The system provides the patient’s blood test information for the student to assess and determine the treatment.

ABGs: read detailed information
SMA: read detailed information
CBC-CD: read detailed information

The system presents some similar diseases for the student to identify based on the gathered symptoms.
Showing the student’s degree of mastery for each case

The student’s degree of mastery is shown in the table. The student needs to practice the cases marked in red.

Case 1 (pneumonia) and Case 2 (left pneumothorax) need to be practiced to reach a higher degree of mastery.
Experimental design

- Participants: 46 students from the nursing department of a university in southern Taiwan

<table>
<thead>
<tr>
<th>Group</th>
<th>Control</th>
<th>Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning method</td>
<td>Traditional approach</td>
<td>Context-aware m-learning approach</td>
</tr>
<tr>
<td>N</td>
<td>24</td>
<td>22</td>
</tr>
</tbody>
</table>
Experimental procedure

46 students

Class-room

In-class teaching

Pre-test

Nursing lab

Experimental group
N = 22

Cognitive apprenticeship approach with the RFID-based mobile learning system

Control group
N = 24

Traditional approach with learning sheets

Class-room

Post-test

Nursing lab

Skills test

2 weeks

180 minutes

180 minutes

basic knowledge of the respiratory system
### ANCOVA result of the students’ learning achievement

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>S.D.</th>
<th>Adjusted Mean</th>
<th>Std. Error</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>experimental</strong></td>
<td>22</td>
<td>78.14</td>
<td>9.40</td>
<td>76.2</td>
<td>2.09</td>
<td>45.26*</td>
</tr>
<tr>
<td><strong>control group</strong></td>
<td>24</td>
<td>53.13</td>
<td>8.48</td>
<td>54.89</td>
<td>1.98</td>
<td></td>
</tr>
</tbody>
</table>

*p<.05*
Skill performances

- Significance was found between two groups in terms of skill accuracy and smoothness dimensions.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Std. deviation</th>
<th>N</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>87.32</td>
<td>10.26</td>
<td>22</td>
<td>2.20*</td>
</tr>
<tr>
<td>Control</td>
<td>77.83</td>
<td>17.72</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Smoothness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>87.75</td>
<td>10.55</td>
<td>22</td>
<td>2.41*</td>
</tr>
<tr>
<td>Control</td>
<td>75.21</td>
<td>22.38</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>

*p<.05
Other findings and implications

- The experimental group showed **lower cognitive load and better learning attitude** than the control group.
- It is effective to foster students the competence of applying integrated knowledge with clinical skills to nursing problems using mobile, wireless communication and sensing technologies.
A Context-Aware Ubiquitous Learning Environment for Conducting Complex Science Experiments

- a context-aware u-learning environment is developed for guiding inexperienced researchers to practice single-crystal x-ray diffraction operations.

- Single-crystal X-ray structure determination is an important experiment for Chemical and Material Sciences
  - which provides the most convincing evidence to reveal the 3D structure of a compound material.
Background and Motivation

- It is time-consuming to train a new researcher (usually 6 months to 1 year)
- The operations could be dangerous, and hence the learner requires full-time guidance during the training process
- Development of a context-aware u/m-learning system for training the “Single-Crystal X-ray Diffraction” procedure in a Chemistry course.
- The learners are master or PhD students in chemistry or material science departments.
Microscope products – examining, selecting, crystal mounting

Ubiquitous learning environment

Context of learner

Give advice or hints based on the context

RFID

Instructing

Data transmitting

Indexing, data collecting

Single Crystal X-ray Diffractometer

Data transmitting

Data processing & Structure determination

Location: 2nd floor, R 204

Location: 2nd floor, R 203

Location: 1st floor, R 126

Ubiquitous learning environment

Context of learner

Give advice or hints based on the context

RFID

Instructing

Data transmitting

Indexing, data collecting

Single Crystal X-ray Diffractometer

Data transmitting

Data processing & Structure determination

Location: 1st floor, R 126

Ubiquitous learning environment

Context of learner

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Data transmitting

Data processing & Structure determination

Location: 1st floor, R 126
Stage 1: Select a crystal of **good quality and suitable size** through an **optical microscope** and mount the crystal on the top of the glass fiber.

The expert system guides the learner to complete the procedure and check if the selected crystal is usable.
Stage 2: Analyze the crystal by operating the X-ray diffractometer to find the cell constants within acceptable deviation.

This stage is very complex since there are several rules to be followed and various parameters to be considered.
Stage 3: Determine the 3D structure of the crystal-line solid using a special program

The outputs of the program include the shape, the exact distance between atoms, and other parameters for describing the structure.
Benefits of the context-aware u/m-learning approach

- based on the responses from 5 researchers who had 6 months experiences and the system logs of 5 new learners

<table>
<thead>
<tr>
<th></th>
<th>Traditional Approach (mean, S.D.)</th>
<th>U-learning Approach (mean, S.D.)</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average number of experiments</td>
<td>1.9 (0.55)</td>
<td>8 (2.38)</td>
<td>-5.59**</td>
</tr>
<tr>
<td>conducted per week</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of mistakes made per</td>
<td>2.3 (0.65)</td>
<td>0.32 (0.08)</td>
<td>6.75***</td>
</tr>
<tr>
<td>experiment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average time needed to deal with</td>
<td>2.5 days (0.66)</td>
<td>0.45 days (0.15)</td>
<td>6.77***</td>
</tr>
<tr>
<td>faults in an experiment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time for fully understanding the</td>
<td>5.5 months (1.49)</td>
<td>2 months (0.45)</td>
<td>5.04**</td>
</tr>
<tr>
<td>operating procedure</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**p<.01, *** p<.001
Designing dynamic English: a creative reading system in a context-aware fitness center using a smart phone and QR-Codes

- English for Specific Purposes (ESP) with interaction design has been a focus in recent years
- A reading system is developed to guide college students to learn in a context-aware fitness center using smart phones and QR-Codes
Interacting with the fitness learning environment—by scanning QR-codes to start learning tasks and access supplementary materials for the learning objects.
Interacting with the fitness learning environment - following the instructions of the learning system to do exercises
The content of learning material was **developed based on dialogues** instead of texts, since talking is more common than reading in an authentic fitness center environment.

---

**Grace:** Achilles' tendon?

**Johnson:** Yes. Putting the lever pad behind your Achilles' tendon will help you work your calf. Now please lay face down and keep your torso flat on the bench.

**Grace:** Is this right?

**Johnson:** Yes. Now raise the lever pad toward your thighs by flexing your knees, and then lower the lever pad and bring your legs back to the starting position.
Keyword search functions

Well, the treadmill is one of the most popular fitness machines. If you want to workout your arms, you can try the biceps curl machine and the triceps extension machine.

No problem. You should think about using one of the treadmills, they can really help you burn a lot of calories in a short time.

Why is a treadmill so good at burning fat?

The treadmill console shows
The smart phone interface showing the keywords in yellow for the user to scan the QR code

Well, the **treadmill** is one of the most popular fitness machines. If you want to workout your arms, you can try the **biceps curl machine** and the **triceps extension machine**.
The result of QR code scanning and (b) the mini-test interface

A device having an endless belt on which an individual walks or runs in place for exercise or physiological testing (from Webster’s dictionary 10th edition)
http://www.treadmilladviser.com/

1. ___ A device with an endless belt on which an individual walks or runs.
   - a. increase workout intensity
   - b. treadmill
   - c. build up your body
   - d. burn off some fat
   - e. flat benches

29:47
Development of a Collaborative Ubiquitous Learning Platform based on a Real-Time Help-Seeking Mechanism

- Provide a help-seeking mechanism on smartphones to help students find right persons who are able to assist them to solve problems encountered in the real world during the learning process.

- An experiment was conducted in a “Personal Computer-Assembling” activity of a university in northern Taiwan.
Learning scenarios of the PC-DIY ubiquitous learning activity

Scan QR-code to derive required instruction of each component

Log in the context-aware u-learning system
Select the requests they would like to deal with

Agree to provide assistance

Solve problems collaboratively

Find experienced learners

Inform the recommended helpers

Send requests
Brief of the learning mission

Welcome to CULP system!

Safety Aspects of Computer Assembly
Anomaly Detection of Boot
CPU

Assembly Key: (Please do not take off CPU for this experiment)

Principles: Put down vertically, watch out for pins and CPU Fan
Detail
Go Back

A Central Processing Unit (CPU), or sometimes just called processor, is a description of a class of logic machines that can execute computer programs. This broad definition can easily be applied to many early computers that existed long before the term "CPU" ever came into widespread usage. The term itself and its initials have been in use in the computer industry at least since the early 1960s (Weik 1961). The form, design and implementation of CPUs have changed dramatically since the earliest examples, but their fundamental operation has remained much the same. (Information)
Interface for seeking help requests and responding to the requests
Experiment design

- Learning task: PC-DIY (the assembly of personal computers).
  - The students need to identify each part of a personal computer (such as CPU, RAM, HDD, CDROM, Floppy Disk, Recovery card, Power supply, Monitor, Keyboard, and Mouse) and assemble those parts into a workable computer.

- The task completion time is used as an indicator for evaluating learning efficiency.
- The smaller value a group gains, the better learning efficiency it represents.
Participants: 58 freshman from a university in Taiwan

- The experimental group (N=29) learned with the proposed approach
- The control group (N=29) learned with the traditional instruction.
  - If they had any questions, they were allowed to ask the TA.
Experimental result- learning efficiency

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>29</td>
<td>42.41</td>
<td>11.16</td>
<td>-6.328***</td>
</tr>
<tr>
<td>Control group</td>
<td>29</td>
<td>62.52</td>
<td>12.96</td>
<td></td>
</tr>
</tbody>
</table>

*** $p < .001$
Discussion

- Advantages of the u/m-learning approach
  - Providing a personalized guide for individual students in authentic scenarios
  - Providing supplementary materials and hints in the right place and at the right time
  - Motivating the students to learn
  - Improving students’ learning achievements and skills

- To further promote students’ learning performances, more effective learning supports or knowledge construction tools are needed
Advanced applications
- Leading in Mindtools or other learning strategies
Definitions of Mindtools

- Jonassen (1999, p9) described Mindtools as “a way of using a computer application program to engage learners in constructive, higher-order, critical thinking about the subjects they are studying.”
Mindtools used in our studies

- Grid-based Mindtool (i.e., repertory grid)
  - Helping students organize the information for identify and differentiate a set of learning targets based on the features of the targets

- Concept maps (a graphical tool)
  - Helping students identify the relationships between what they have observed in the field and their prior knowledge learned from the textbooks
Grid-based Mindtool- Repertory grid

- Identify a set of diseases based on the observed symptoms of the patient

Features for identifying the disease.

### Elements (e.g., names of the diseases)

<table>
<thead>
<tr>
<th>Positive feature (1)</th>
<th>Pneumothorax</th>
<th>Airless lung</th>
<th>Bronchitis</th>
<th>Pneumonia</th>
<th>Opposite feature (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cough</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>No cough</td>
</tr>
<tr>
<td>Accessory muscle used</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>No accessory muscle used</td>
</tr>
</tbody>
</table>

Positive (1) ←-------- relationship between them --------→ opposite(5)

A 5-scale rating mechanism
George Kelly—the Creator of Repertory Grids (凱利方格)

- April 28, 1905 – March 6, 1967
- An American psychologist, therapist and educator.
- Best known for developing Personal Construct Psychology
Conducting Mobile Learning Activities for Clinical Nursing Courses based on the Repertory Grid Approach

- The learning environment is a simulated sickroom
- Several standard patients (i.e., the persons who play the role of patients with specific diseases) with different diseases are placed.
Learning scenarios

The students were guided by the learning system to visit the patients and collect their symptoms to organize their own repertory grids.
There are eight symptoms for identifying nine diseases.

In each observation iteration, two patients with different diseases are observed.

For each pair of patients, the students are guided to observe the eight symptoms and record their findings in the repertory grid.

Each pair of patients to be visited is determined by the teacher in advance based on the diseases and the symptoms they have.
The learning system asks questions following the learning sequence determined by the teacher.

After the students finish observing the eight symptoms for a pair of patients, the learning system guides them to visit the next pair of patients for further observation.

The learning process is ended after the students’ repertory grids are complete.
The student walks close to the patient suffering from “Airless lung” and makes detailed observations.

Hint: collect the information of the target patient.

The basic information of the target patient includes name, age, gender, height and weight.

Historical data of the patient: having a fever with much sputum in the previous week, coughing, having had a stroke five years ago, and relying on nursing.
The student judges that the symptom to differentiate Asthma and Atelectasis is sputum.

The student fills in the values for the two diseases.
The observed disease: Tuberculosis

Chest pain is found.

The percussion sound is dullness.

Sputum is found.

The patient has a cough.

The auscultation sound are rales.
The First Stage

Taking Nursing Training Program, 48 students

Traditional instruction in the classroom

10 hours

The Second Stage

In the Classroom

Pre-test and pre-questionnaire

30 Min.

Guided by the proposed approach

Guided by the conventional approach

120 Min.

In the Nursing Laboratory

25 students

Learning, 23 students

In the Classroom

Post-test and post-questionnaires

50 Min.

Mobile Learning Research in Specific Disciplines
Results

- The students who learned with the repertory grid-oriented mobile learning approach showed better learning achievement, attitude and lower cognitive load than those learning with the conventional approach.

- This implies the importance of providing learning supports for u/m-learning activities.
On-going mobile learning promotion programs in Taiwan

- Mobile learning promotion program for elementary and junior high schools
  - 100 schools/year since 2012
- Mobile learning promotion program for senior high schools and vocational schools
  - 40-50 schools/year since 2013
- Mobile MOOCs program
  - 4-5 universities/year since 2015
Training programs for school teachers

Introduction to the objectives of the program

Experience sharing by school teachers

Training courses for teaching plan design

Q&A
In-class activities

In-field activities
Mobile Learning Experiences in Taiwan
Challenges of doing mobile/ubiquitous learning studies

- Finding suitable subjects unit for conducting m/u-learning activities
  - What is the objective of the selected unit?
  - What is the role of mobile technology in the study?
  - How can the mobile technology benefit students during the learning process?

- Leading in or proposing effective learning strategies or tools to help students learn better
Research Issues of mobile and ubiquitous learning

- Proposing or adopting strategies or tools for supporting m-learning or u-learning activities
- Developing adaptive or collaborative m-learning or u-learning environments
- Investigating students’ real-world learning status from different aspects, such as
  - learning achievement and problem-solving skills
  - learning style and cognitive style
  - cognitive load, learning motivation and attitudes
  - learning behaviors and learning patterns
- Re-examining some well-recognized e-learning issues, such as TAM
New idea- Seamless flipped Learning
-Integration of mobile learning and flipped learning

**Seamless Flipped Learning**

Mobile devices with wireless communications

Learning from the tutoring videos
Make annotations and search for relevant data at home, and bring all of the materials to the in-class discussion or activities

At home

In class

In the field

Various learning activities can be conducted using mobile technology

Collect data and experience in the field
Bring the collected data and learning diaries to the class


Mobile Learning Research in Specific Disciplines
Seamless Flipped Learning

1. Issue-quest learning
   - Using application software or supplementary materials for extension courses and discussion

2. Knowledge Construction Tools
   - Mobile devices with wireless communications

3. Peer Competition or gaming
   - Collaborative project-based learning and knowledge sharing

4. Problem-based learning
   - Individual project-based learning

5. In class

6. In the field

7. Peer assessment

8. At home
Discussion
What are the features of the existing mobile learning studies and applications?

Are those features also in the some units of the courses you know or teach?

What are the learning problems students encountered in these courses?

Can mobile/ubiquitous learning approaches solve the problems? How?
Questions and Answers
References


