出國報告（出國類別：國際會議）

參加「2014年國際學習科技與學習環境研討會」及發表論文

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派赴國家：日本
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摘要

近年來由於無線網路、感測技術與行動科技的進步，為數位學習帶來很大的變化，透過這些新興科技，學習者得以不受時空限制獲得數位資料的支援，同時，學習系統亦可紀錄學習者學習狀態與學習成效。日本北九州大學所舉辦「2014 年國際學習科技與學習環境研討會」提供研討平台，進行數位學習研究的相互溝通機會，隨著國軍事務革新的同時，越來越多教育訓練需要數位學習系統的輔助與協助，返國報告除說明研討會內容之外，亦指出行動擴增實境技術將是數位學習的新介面。

目次

壹、 目的

參與「2014 年國際學習科技與學習環境研討會」主要目的為發表論文，論文名稱為” A Mobile Augmented Reality Based Scaffolding Platform for Outdoor Fieldtrip Learning”，透過與各國學者進行意見交換與經驗交流，以期進一步將研究成果，更完整投稿至國際知名期刊論文。由於所參與國際研討會主要是由 International Conference on Advanced Applied Informatics(先進應用資訊研討會)為主軸，並涵括第五屆電子服務與知識管理(E-Service and Knowledge Management，ESKM)、第三屆學習科技與學習環境 LTLE(Learning Technologies and Learning Environments)、第三屆機構研究與機構管理 (Institutional Research and Institutional Management，IRIM), 第二屆智慧運算與人工智慧(Smart Computing and Artificial Intelligence，ICSCAI) 等四個子研討會；另外亦聯合第 12 屆軟體工程、管理與應用 SERA(Software Engineering Research, Management and Applications，SERA)，第 1 屆資訊科學及智慧研討會(Computer Science and Intelligence，CSI)與第 2 屆應用運算與資訊科技 ACIT(Applied Computing & Information Technology)等數個研討會共同舉辦。因此也利用這個難得的機會參與其他研討會，參與有關數位學習與資訊科學相關技術研討。

貳、 過程

「2014 年國際學習科技與學習環境研討會」原為日本知名研討會，過去幾年在大會用心經營與日本地方政府的支持下，參與人員逐年增加並擴及全世界各地學者、教師和專業人員，今年所參與的國家除了日本之外，另有美國、中國大陸、澳洲、墨西哥、捷克、泰國、印尼、馬來西亞、越南、巴林與埃及等各國學者與研究人員；當然還包含我國中央大學、成功大學、師範大學、台灣科技大學、東華大學、台南大學、台北城市大學、東吳大學與國防大學理工學院等研究學者。「2014 年國際學習科技與學習環境研討會」提供數位學習與相關教育科技研究與實務交流平台，並舉辦多場次講習與研討，除了邀請知名學著擔任演講嘉賓說明最新研究方向之外，另藉由與會人員交流分享數位學習與教育環境應用技術之最新發展，以期擴大創新與多元之教育成果，提升學生學習效益與動機。

首日於 8 月 30 日中午抵達日本福岡(Fukuoka)機場，經過一番摸索後始由國際機場轉乘機場內巴士至國內線機場，再經尋找複雜機場動線後，轉搭捷運至博多(Hakata)站，由於博多為日本北九州重要交通樞紐，在博多轉乘九州旅客鐵道(Kyushu Railway)至小倉(Kokura)，加上小倉車站很大且有多個出口，抵達大會推薦 APA 旅館時天色已晚。隔天 8 月 31 日開始一早至研討會辦理報到，如圖 1 為與大會議程主席 Yuichi Ono 教授攝於會場前，今年參與會議的台灣學者包含中央大學、成功大學、師範大學、台灣科技大學、東華大學、台南大學、台北城市大學、東吳大學與國防大學理工學院等學校的相關研究教授與學生。大會一開始是由台灣成功大學黃悅民教授以”Affective Learning and Pedagogy using affective computing”為題，進行專題演講，介紹情感運算技術，並運用於情感教學與教育上。情感運算技術係透過使用者所穿戴或手持之各種感測器，擷取由情感所引起的表情及生理變化信號，並針對所擷取的信號進行辨識，配合使用者的模型進行情感理解，以做出適當回應，黃教授將情感運算運用於情感教學上，演講過程內容，透過黃教授精闢的講解，給予在場研究學者多方面的研究啟發。之後，大會便開始正式的研討會，以下針對大會所舉辦的六個研討議題，分別摘要報告。

- 第一個 Session(LTLE-1) 於 8 月 31 日舉行，由日本築波大學 Yuichi Ono 教授主持，首先由日本九州(Kyushu)大學，報告”Classification and clustering English writing errors based on native language”論文，日本九州(Kyushu)大學透過分析 SNS 網站 Lang-8 外語學習系統，運用分類與叢集演算法進而找出常見 15 種英文寫作錯誤之處；接者由日本築波大學 Yuichi Ono 教授，如圖 2，報告”Implementation and evaluation of real time qualitative feedback systems in a foreign language presentation course”論文，主要目的為實現築波大學現有外語學習系統並發展評估即時量化系統，為外語教學上很有趣的研究議題。

- 第二個 Session(LTLE-2)於 9 月 1 日舉行，由台灣東吳大學朱惠君教授主持，首先台科大黃國禎教授團隊 Sung Han-yu 同學以"An Integrated Contextual and Web-Based Problem-solving approach to improving students' learning achievements, attitudes and critical thinking"為題發表，整合情境化與網路化問題教學方式以改善學習成效、學習態度與批判式思考等研究議題，並進一步探討實驗分析結果；接者，同樣的台科大 Lai Chiu-Lin 同學，以"A peer-assessment criteria development approach to improving critical thinking of students"發表，以美術課程海報設計為例，發展一套同儕式互評系統，研討過程中點出建立評判標準時，可以採用選單式來取得量化(benchmark)的評判方式，並可減少老師回覆時間。然後，台科大 Shao-chen Chang 同學，以"Effects of In-Field Mobile-Based Learning Activities on Students Local Culture Identity"為題，探討運用於本地課程之實地行動遊戲，並透過觀察使用者狀態來取得學習成效；緊接著，台南大學 Huang Iwen 教授，以"Effects of an Integrated Scratch and Project-Based Learning approach on the learning achievements of gifted students in computer courses"，運用簡易的 Scratch 軟體與專案導向學習方式，在電腦學習課程中提升國中資優生學習成就；最後，台南大學 Yu-Rong Liao 同學，以"An Investigation of Junior High school students' online historical-documents reading literacy"為題，探討國中學生線上歷史文件閱讀素養調查報告，如圖 3 為 LTLE-2 發表成員合影。

- 第三個 Session(LTLE-3)於 9 月 2 日舉行，由中央大學教授楊接期教授主持，首先台南大學洪碧霞教授以"Investigation on collaboration competency of elementary school students in ubiquitous problem-based learning"為題，檢視戶外實地教學中學生協同完成問答流程，如何運用無所不在學習環境(ubiquitous learning environment)提升協同問答能力與學術表現；接著中央大學 Sherry Teng 同學，如圖 4，以"How game experiences affect game behavioral patterns in a MMOPRG-based learning environment?"為題，探討多人線上遊戲(MMORPG)的仿真環境、角色扮演與團隊合作等遊戲經驗，如何用以提升學生對於外國語言學習的學生動機；最後台南大學洪碧霞教授團隊以"Development of an Online Reading Literacy Assessment on Life Information after mild stroke"為題進行報告，論文中發展一套線上閱讀文獻評估系統(ORLALI)，以提升與評估輕度中風病患的閱讀能力。

- 第四個 Session(LTLE-4)於 9 月 3 日上午 0930 時舉行，由日本大阪大學 Noriko Uosaki 教授主持，首先，如圖 5，以"A mobile augmented reality based scaffolding platform for outdoor fieldtrip learning"為題，進行第一場報告，針對戶外實地教學(Outdoor Field Learning)課程，提出一套周遭感知行動擴增實境(Mobile Augmented Reality)學習平台，稱作歷史時光隧道(Historical

Time Tunnel, HTT)。戶外實地教學課程旨在教導學生當地歷史演進事件與經驗傳承。全文內深入探討歷史時光隧道(HTT)的系統原理，並透過一連串的系統效能與驗證；且針對六年級學生實施使用本系統之前後問卷調查，結果證實歷史時光隧道(HTT)系統確實可扮演好老師與學生之間的輔助鷹架角色，有效提升學習成效。報告過程中與其他與會人員，針對情境感知(Context-aware)與鷹架理論(Scaffolding)進行熱烈探討。接者，大阪大學 Noriko Uosaki 教授以”Enhancing Outside-class learning using online tools: A review work”進行報告，Noriko Uosaki 教授為國際知名數位學習專家，過去以推動日本語為第二外國語言(Japanese as second language，JSL)研究著稱，本研究提出檢視過去相關 JSL 相關工具，並提出一套 SCROLL 系統來提供使用者學習日語；最後，是由台北城市大學王俊嘉副教授，以”The implementation of a context-aware mobile Japanese conversion learning system based on NFC-enabled smartphones”，報告如何運用智慧型手機上的 NFC 裝置，實作日語會話學習系統。

- 第五個 Session(LTLE-5)於 9 月 3 日上午 1100 時舉行，由日本築波大學 Yuichi Ono 教授主持，如圖 6，首先由 Hiroshima City 大學 Chunming Gao 教授以”A Study of Using Handwritten Annotations on Digital Textbooks”為題，說明在平板電腦上針對數位電子書所開發之手寫介面，這套介面可針對使用者在電子書中的標註，自動產生相應的問題，以加強學生的主動學習的能力；其次，是由北九州(Kitakyushu)大學 Taku Jiromaru 同學，以”Instructional Design of Exercise-Centric Teaching Materials on UML Modeling”為題進行報告，Susumu Yamazaki 教授團隊的 Taku Jiromaru 同學以統一模式語言(UML)進行以練習為主的教學教材設計，並結合循序漸進的學習策略，以提升學習效益；最後同樣是由北九州(Kitakyushu)大學 Susumu Yamazaki 教授，針對”Instructional Design of a Workshop “How a Computer Works” Aimed at Improving Intuitive Comprehension and Motivation”，進行說明，論文目的主要針對計算機運作，進行教學設計，以拉近過去一般學生對於程式撰寫的鴻溝，以更為直覺化理解方式改進學習動機。

- 第六個 Session(LTLE-6)於 9 月 3 日下午 1510 時舉行，由日本德島大學 Kenji Matsuura 教授主持，如圖 7，首先由台灣師範大學 Yi-Ting Yang 同學進行報告，題目為”Concept Maps Construction Based on Student-Problem Chart, Supporting system for the form improvement on rope skipping skill by image processing”， Yi-Ting Yang 同學說明該研究利用學生問題圖表(Student-Problem Chart)取代過去以往的資料探勘技術，能更精確獲得學生問題類型，實驗中從 30131 個學生歸納出六個學生常見的學習問題類型；接者，Tokushima 大學 Shinya Yoshioka 同學以 ePortfolio System Design based on

Ontological Model of Self-regulated Learning 為題，針對自我調整學習理論(Self-regulated Learning，SRL)進行研討，並以 Ontological model 提出一套 ePortfolio 系統，實驗結果說明所設計的系統可以驗證 SRL 具正向回饋，最後是由巴林大學 Hamdy Ahmed Abelaziz 教授針對 Immersive Learning Design (ILD): A New Model to Assure the Quality of Learning through Flipped Classrooms 進行說明，Hamdy Ahmed Abelaziz 教授為最新熱門的翻轉教室提出一項沉浸式學習設計(ILD)，以確保學習品質。

在參加最後一個 Session 之後，旋即回到飯店撰擬返國報告，並於隔天(9 月 4 日)中午搭機返國。

參、 心得及建議

「2014 年國際學習科技與學習環境研討會」為第一次參與有關數位學習的研討會且也是第一次到日本，此次參與研討會成員雖然來自全世界各地，不過大多還是日本與亞洲有關學者，整個參與過程，除了由於對於日語與交通動線較不夠熟悉之外，其餘對於大會所用心安排的行政與住宿等感到非常滿意，尤其對於日本的精緻文化與謹慎小心的工作態度更是感到非常佩服，提供以後辦理相關國際研討會非常許多參考，例如，會議中心應該在主要車站附近，且能提供多樣化住宿選擇；另外議程與動線安排上亦可以結合地方政府周邊宣傳與贊助，擴大研討會學者與研究專家參與效益，提升國家整體軟實力。

數位學習的研究方向，已從傳統的遠距學習，到現今常見的電子學習(e-learning)，隨著行動載具普及化，亦帶來了行動學習(M-learning)，而新一代的無線寬頻技術更是催生無所不在學習(Ubiquitous learning)，越來越多的研究學者投入相關議題的探討。然而從本次研討會中可以發現，無所不在學習(Ubiquitous learning)除了原來教育人員投入之外，需要更多資訊科技人員的投入，以提升學習效益。此次在參與「2014 年國際學習科技與學習環境研討會」過程中，發現包括行動與情境感知技術在教育情境之應用系統、數位內容、教學策略、評量方法、學習效果、學習歷程、與應用感受之評估方法與技術等皆為熱門研究議題。

隨著人機資訊介面與雲端技術之進步，相關研究亦如雨後春筍般出現在各式應用中，然而受限於前端操作裝置的運算資源與儲存空間，前端操作裝置本身無法完成太複雜的影像辨識、狀態推論、以及儲存大量資料等工作來滿足新一代的系統服務應用需求，例如以影像進行周遭環境辨識與定位，進而提供視訊串流顯示。但隨著無所不在計算(Ubiquitous computing)技術日漸成熟，部分複雜運算可以轉移至後端伺服器計算，再將計算之後的模式資料即時回傳至前端操作裝置，再以適切方式顯示給學習人員，讓前端操作裝置的計算需求大為降低，故所能提供的各式人機介面應用服務將更廣泛。這類新一代行動擴增實境之人機介面與影像處理技術在無所不在學習(Ubiquitous learning)環境中更將扮演舉足輕重的角色，讓原本已經在行動導覽系統上已經大放異彩的行動擴增實境技術，開創出新的應用與研究方向。

國防大學理工學院扮演國防科技整合的重要角色，適時提供國軍各級單位顧問諮詢與技術支援等任務，近年來隨著國軍作戰形態已逐步轉型為聯合作戰，聯合作戰訓練與教育遂成為國軍重點發展方向，合成化訓練環境(Live, Virtual and Constructive Training Environment, LVCTE)近來即在新一代高階模擬架構(High Level Architecture, HLA)演進下，整合各式網路，包含有線網路(Wired Network)及無線網路(Wireless Network)，將實兵作戰(Live)系統、模擬(Virtual)系統與兵棋(Constructive)系統等皆整合在共同之訓練戰場內，遂行三軍聯合作戰訓練的新興研究議題，相關數位學習系統，包含知識庫的建構、人機介面、訓練方式與評估等技術，

隨著國軍逐步開放智慧型裝置的同時將越顯重要，建議未來國軍各級單位可朝向無所不在學習(Ubiquitous learning)環境進行研究與分析，如此一來即可一方面將可提升國軍人員專業能力，另一方面更可提升作戰訓練效益。

非常感謝本次在國防大學理工學院各級長官指導與科技部計畫協助下，得以參與此次的國際研討會。藉由參與本次研討會觀摩與研討，得以瞭解數位學習的最新研究方向，並透過論文發表逐漸與國際著名學者接軌，對在學術研究與國際視野有相當大的提升，希望未來能持續朝這個方向努力為國軍教育訓練與國防科技奉獻己力。

肆、　附錄

一、　會議議程

Sunday, August 31

10:30AM-11:10AM (40 min)	[AAI-LTLE-Keynote] "Affective Learning and Pedagogy using Affective Computing", Yueh-Min Huang, Ph.D. (National Cheng Kung University, Taiwan)	Room B

11:10AM-12:00PM (50 min)	[LTLE-1] Session Chair : Yuichi Ono (University of Tsukuba, Japan)	Room B

Classification and clustering English Writing Errors based on Native language

Brendan Flanagan, Chengjiu Yin, Takahiko Suzuki, Sachio Hirokawa (Kyushu University, Japan) [LTLE-1:21]

Implementation and evaluation of real time qualitative feedback systems in a foreign language presentation course

Yuichi Ono, Sachio Hirokawa, Manabu Ishihara, Mitsuo Yamashiro (University of Tsukuba, Japan) [LTLE-1:34]

Monday, September 1

9:30AM-11:35AM (125 min)	[LTLE-2] Session Chair : Hui-Chun Chu (Soochow University, Taiwan)	Room B

An Integrated Contextual and Web-based Problem-Solving Approach to Improving Students' Learning Achievements, Attitudes and Critical Thinking

Gwo-Jen Hwang, Han-Yu Sung, Hong-Sheng Chang (National Taiwan University of Science and Technology, Taiwan) [LTLE-2:20]

A peer-assessment criteria development approach to improving critical thinking of students

Chiu-Lin Lai, Gwo-Jen Hwang (National Taiwan University of Science and Technology, Taiwan) [LTLE-2:22]

Effects of In-Field Mobile Game-based Learning Activities on Students' Local Culture Identity

Shao-chen Chang, Gwo-Jen Hwang (National Taiwan University of Science and Technology, Taiwan) [LTLE-2:23]

Effects of an Integrated Scratch and Project-based Learning Approach on the Learning

Achievements of Gifted Students in Computer Courses

Hsiu-Ying Wang, Iwen Huang, Gwo-Jen Hwang (National University of Tainan, Taiwan) [LTLE-2:25]

An Investigation of Junior High School Students' Online Historical-Documents Reading Literacy

Yu-Rong Liao, Pi-Hsia Hung, Gwo-Jen Hwang, Wen-Yi Chang (National University of Tainan, Taiwan) [LTLE-2:28]

6:00PM-7:30PM	Banquet

Tuesday, September 2

9:25AM-11:00AM (95 min)	[LTLE-3] Session Chair : Yueh-Min Huang (National Cheng-Kung University, Taiwan)	Room B

Investigation on collaboration competency of elementary school students in ubiquitous problem-based learning

Yueh-Hsun Lee, Gwo-Jen Hwang, Pi-Hsia Hung , I-Hwa Lin (National University of Tainan, Taiwan) [LTLE-3:30]

How game experiences affect game behavioral patterns in a MMORPG-based learning environment?

Jie Chi Yang, Sherry Teng (National Central University, Taiwan) [LTLE-3:32]

Development of an Online Reading Literacy Assessment on Life Information after mild stroke

Yu-Ching Huang, Pi-Hsia Hung, Ku-Chou Chang (National University of Tainan, Taiwan) [LTLE-3:35]

6:00PM-7:30PM	Conference Reception

Wednesday, September 3

9:30AM-10:45AM (75 min)	[LTLE-4] Session Chair : Noriko Uosaki (Osaka University, Japan)	Room B

A Mobile Augmented Reality Based Scaffolding Platform for Outdoor Fieldtrip Learning

Chung-Hsien Tsai, Jiung-Yao Huang (National Defense University, Taiwan) [LTLE-4:29]

Enhancing Outside-class learning using online tools: A review work

Gustavo Inoue, Noriko Uosaki , Hiroaki Ogata, Kousuke Mouri (Osaka University, Japan) [LTLE-4:31]

The Implementation of a Context-Aware Mobile Japanese Conversation Learning System Based on NFC-enabled Smartphones

Chun-Chia Wang, Ching-Ren Wei (Taipei Chengshih University of Science and Technology, Taiwan) [LTLE-4:40]

11:00AM-12:15PM (75 min)	[LTLE-5] Session Chair : Chengjiu Yin (Kyushu University, Japan)	Room C

A Study of Using Handwritten Annotations on Digital Textbooks

Noriyuki Iwane, Chunming Gao (Hiroshima City University, Japan) [LTLE-5:27]

Instructional Design of Exercise-Centric Teaching Materials on UML Modeling

Susumu Yamazaki, Taku Jiromaru (University of Kitakyushu, Japan) [LTLE-5:37]

Instructional Design of a Workshop "How a Computer Works" Aimed at Improving Intuitive Comprehension and Motivation

Susumu Yamazaki, Takashi Satoh, Taku Jiromaru, Nobuyuki Tachi, Masafumi Iwano (University of Kitakyushu, Japan) [LTLE-5:38]

3:10PM-4:50PM (100 min)	[LTLE-6] Session Chair : Kenji Matsuura (University of Tsukuba, Japan)	Room C

Concept Maps Construction Based on Student-Problem Chart

Jiann-Cherng Shieh, Yi-Ting Yang (National Taiwan Normal University, Taiwan) [LTLE-6:19]

Supporting system for the form improvement on rope skipping skill by image processing

Shinya Yoshioka, Keita Yamada, Kenji Matsuura (The University of Tokushima, Japan) [LTLE-6:24]

ePortfolio system design based on ontological model of self-regulated learning

Lap Trung Nguyen, Mitsuru Ikeda (Hoa Sen University, Viet Nam) [LTLE-6:33]

Immersive Learning Design (ILD): A New Model to Assure the Quality of Learning through Filliped Classrooms

Hamdy A. Abdelaziz (Arabian Gulf University, Bahrain) [LTLE-6:39]

二、　發表論文全文

A Mobile Augmented Reality Based Scaffolding Platform for Outdoor Fieldtrip Learning

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***Abstract*—Mobile learning provides learners with the capability to assimilate courses anywhere in any time. However, most of the existing Mobile learning systems only allows learners to passively receive knowledge without considering the temporal and spatial information of the learners. The paper proposed a context-aware mobile augmented reality learning platform, called Historical Time Tunnel(HTT), as scaffolding platform for outdoor field learning. The location-based nature of Augmented Reality(AR) technology, AR-based Mobile learning systems could enable learners to acquire the historical interactive knowledge that are related to the specific geographical location. Through such direct interaction with location-based information provided by AR-based M-learning technology, the knowledge acquisition efficiency can be significantly boosted. The designed HTT system not only focuses on student learning management module but also provides teaching material management module for teachers. The conducted experiments on the elementary school student successfully prove that HTT system is an effective scaffolding tool for the novice teachers as well as a helpful assistant to the experienced teachers.**

Keywords—Scaffolding; Mobile Augmented Reality; Outdoor Fieldtrip Learning; Local Culture

I. INTRODUCTION

Although E-learning is an excellent platform for the students to work and learn at their own paces and places without the restriction of time and location compare to the traditional learning. However, there are some problems with E-learning. For examples: How to build their self-learning skills? How to avoid distraction from information overflow or isolation? How to maintain students' interest and persistence? Hence, E-learning requires support and structure to assist the students. Different approaches of Scaffolding[1] in E-learning are then proposed over the years. Furthermore, with advance of mobile technology has promoted the utilization of smart devices application in our daily life. In recent years, E-learning researchers notices that the process of mobile technologies have changed with portability and interactivity. The objective of M-learning is to provide the learner with the ability to assimilate learning anywhere at any time. M-learning technology focuses on the mobility of the learner and interaction.

A scaffold is a temporary framework that is put up for supporting and assisting students in learning. The framework would be gradually faded away after the students completing the assigned tasks to gain the enough knowledge. It was first introduced in the late 1950 and was promoted by Vygotsky since 1978.[2] There are three categories of scaffolds, including cognitive, meta-cognitive, and affective or motivational scaffolds. Cognitive and meta-cognitive scaffolds provide assistance, support, hints, prompts, and suggestions regarding the content, resources, and strategies relevant to the problem solving and learning management. Motivational scaffolds involve techniques designed to maintain or improve the learner's motivational state, such as attribution or encouragement.

Local culture courses are the lessons teaching students regarding the historical events or geography of an area. The courses mostly emphasize the history and nature of an area. Since the local culture course is the lecture of time, space and event of local features and era background, traditionally, the teacher lectures in the classroom first; then a field trip to the spot of monument or historical event for further exploration would be followed. However, there are several problems of this ordinary approach. First of all, local cultures are the knowledge of past. Hence, the learning performance is dominated by teacher's personal experiences. Secondly, local cultures take place in specific locations. Such monuments may not be well preserved due to the society evolution and generations' variation. Students may not comprehend what the teacher tries hard to explain if the original monument doesn't exist anymore. Furthermore, since the field trip is completely guided by the teacher, the knowledge of the teacher will significantly affect the learning outcomes. Students may also overlook the geographical location of the monument if they are interfered by the surroundings, such as noise or passerby. Students may not concentrate on teacher's instruction during walking or self-guided trip. Teacher can't ensure if individual student indeed fully understands his interpretation. To ensure the learning efficiency, teacher can quiz students, but not all students have the chance or the capability to answer during the interactive atmosphere. Finally, the exploration is not so appealing that students may lose their interests to further explore by themselves. Based on the above issues, it has been the educators' striving target on how to advance students' learning interests and results for local culture courses. Field trip is a way to promote students' learning aspiration but should be supported with proper scaffolds. According to the essence of local culture courses, the scaffold for local culture courses belongs to cognitive type.

This paper proposes a M-learning platform that integrates the interactive and convenient nature of mobile platform and enhances with AR technology and scaffolding theory to support the field trip of local culture course. A prototype system called the Historical Time Tunnel (HTT) system was then designed and implemented for an elementary school in Taiwan for their local culture courses.

II. Related Work

To develop context aware location-based learning system, a variety of new techniques and products concerning M-learning system has three distinct features as following:

A. Location-aware learning

Location-aware learning enables the learning activities to integrate the physical environment and learning contents for the purpose of empowering learners to obtain the best relevant learning information with their physical location. Location-aware learning system usually needs to be equipped with the features of positioning, guiding and context push.[3]

- Positioning: Among the positioning devices, GPS receiver is one of the most regular outdoor positioning sensors. It majorly acquires the satellite signals to determine the position of the GPS receiver. GPS receiver nowadays spreads over various outdoor location-aware learning systems. Whereas WiFi determines the position of the receiver through the radio signal strength broadcasted from IEEE 802.11 wireless base stations. However, limited by the environmental interference and other factors, there are more than ten meters errors existing in the current WiFi positioning technology. For the requirement of closer observation during learning process, the stationary positioning technology, including RFID, QR Code and 2D barcode, etc., is often adopted to provide the additional positioning service.
- Guiding: With accurate positioning data, the system could guide learners through the trail of attractions to conduct their learning behavior according to their positions. Such guiding trail is named as Learning Path. The learning path could be either pre-defined or be generated randomly. For the beginners, because they don't have any prior background knowledge, they should be guided with the pre-defined learning path to establish their background knowledge. After having owned the basic knowledge, learners could start to set up their individual interested learning subjects to dynamically create their personalized learning paths.
- Context Push: Context Push is the most important function of location-aware learning system. It automatically pushes the location related learning contents to the learners based on their current locations and learning path. Hence, the required functions include (a) estimate learners' current locations; (b) take the position data as the index to extract the location-related learning contents from the learning contents database; (c) personalize learning contents based on learner's location and learning history; (d) push learning contents to learners through wireless network.

B. Context-aware ubiquitous learning

The well-known definition of ubiquitous learning is to permit learners to perform their anywhere and anytime learning by means of wireless networks, mobile devices or sensing technology to retrieve various learning context in any locations at any time. Nevertheless, such definition only expresses the learning with ubiquitous computing technology instead of actual ubiquitous learning. For example, the context-aware ubiquitous learning system (CAULS), proposed by Chen and Huang[4], is equipped with radio-frequency identification(RFID), wireless network, embedded handheld device and database to promptly detect students' learning behaviors.

C. Augmented reality mobile learning

Azuma[5] considers AR has the following three features: (1) To integrate virtual and real objects in the same interface space; (2) Promptly interactive mode; (3) To interact with users in three-dimensional physical space. Consequently, an AR M-Learning System should contain three distinct characteristics: Interaction, Extension and Experience. Interaction emphasizes the interaction between learners and environment. Extension indicates the appropriate transition and extension of sensory information; then users could manipulate the virtual information or objects on the screen through environmental sensors. Finally, it could enhance learners' experiences by means of virtual information or objects without the constraints of time and space. For example, [Design and evaluation of a virtual mobile time machine in education] use GPS as the position sensor and integrated with timeline to display historical pictures using AR technique. It allows users to aware historical events at that spots and to increase the learning motivation accordingly.

In order to intensify the efficiency of context in teaching and learning, Abas & Zaman[6] further integrates scaffolding learning theory into AR teaching. Scaffolding learning theory was derived from cognitive study and was based on the concept regarding the learning differences between learner autonomy and peer cooperation.[2] It emphasizes dynamic teaching assessment and learners' learning interaction together with exploration process. Such temporary supporting scaffold could be some kind of teaching tool or teaching strategies. Teachers could gradually transfer the learning responsibility to students with the advancement of their learning capability. Through the learning environment constructed by location-aware detection, behavior perception and augmented reality technologies, it not only could empower students to manage their own learning pace under teachers' assistance, but also could properly adjust their learning behaviors accordingly. Besides, teachers could further provide the additional respective learning assistance based on individual student's learning progress. Students could also actively search their interested learning subjects on Internet. Though each student has different progress and priority of learning; yet, they finally could actively organize what they have learned. It just satisfies the spirits of active learning designed by scaffolding learning theory.

Based upon the above surveys, this paper proposes an AR-based M-learning system for local cultural teaching called

Historical Time Tunnel system (HTT). HTT integrates three distinct features of M-learning with AR technology and scaffolding learning theory to provide location-aware mobile learning environment. It is equipped with three key functions of positioning, guiding and spontaneous pushing to provide context-aware ubiquitous learning platform.

III. THE HISTORICAL TIME TUNNEL SYSTEM

HTT intends to lead the students back to those disappeared or damaged historic attractions to rekindle the ancient memories. Therefore, HTT must be able to provide the immersive, interactive and self-learning functions. The immersion is to reconstruct the visiting disappeared monument on its remaining or spot by means of sounds, images, 3D virtual objects, or video clips on mobile device. However, the immersion should not just one-way passively receive the information provided by the system. Instead, it should inspire students to deal in thorough exploration, and could permit students to interact with those reappeared monuments. Through the immersion and interaction, it should further promote students' learning interests and even to promote their self-learning willingness. The interdependence of those functions is the significant basis of constructing scaffolding learning environment. In order to implement those functions, the system has to know users' locations to orientate the geographical relationship between users and the monument. The system then requires users to register to the environment, and next reconstructs the monuments by means of sounds, images, 3D virtual objects, or video clips on mobile device.

Based upon the above requirements, HTT system aims to solve the problems of traditional field trip exploration, it adopts GPS to locate user's position and to register user to the environment accordingly. HTT system uses GPS to register the student to the space of the visiting monument while QR Code allows student to register to the monument in time. After successful registration, the historical contents of monument are then retrieved wirelessly from the server. In order to ensure the learning outcomes, a set of quiz is designed for each monument. In addition, in order to further enhance student's cognition of geographical location of each monument, AR interface is added for student to browse during the field trip.

The entire system is designed into three layers as illustrated in Fig. 1. The web layer is for the teachers to manage learning material and organize courses from the bank of monuments material. The Data Base layer contains all the required information, such as students' data and various learning materials, for the entire system. The Mobile Device App refers to the APP on student's mobile device.

Since HTT system also allows teachers to organize teaching material and to set up field trip agenda, the operation of the entire system flow can be viewed from the student's perspective or teacher's viewpoint.

Fig. 2 illustrates the system flow from the student perspective. The APP will download the field trip agenda along with the respective quiz once he successfully logins. He then begins to explore the monuments assigned by the course. Whenever the student finishes exploring a monument, he would be asked to answer several quizzes to reinforce his cognition. The answers are then wirelessly uploaded to the server for later retrieved by the teacher.

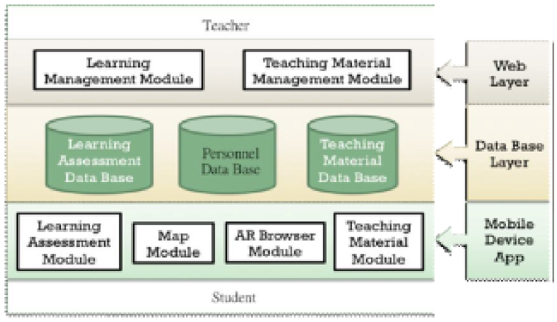

Fig. 1. HTT System Architecture

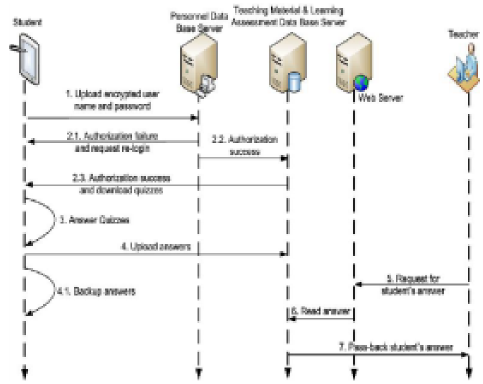

Fig. 2. Student's Flow

Fig. 3 shows the system flow from the teacher viewpoint. The teacher can create course material and organize field trip agenda from the teacher's web page, which is in turn to access monuments from the material database.

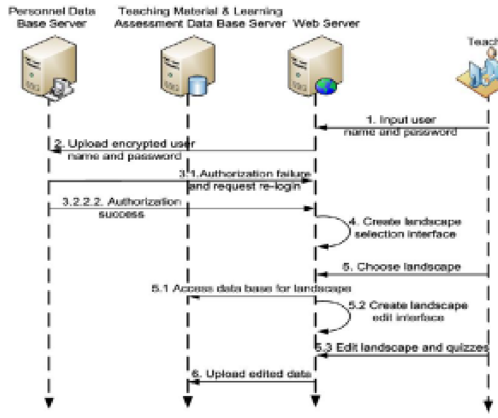

Fig. 3. Teacher's Flow

platform. Omniguider is a mobile augmented reality browser, which is available on both iOS and Android platforms and was designed by our lab in 2010.

From the teacher perspective, the teaching material management module allows teachers to manage field trip teaching material through the web browser. As illustrated in Fig. 4(a), other than enable teacher to set up the scenic spots for the field trip, the multimedia contents can also be uploaded and managed online as illustrated in Fig. 4(b). Fig 4(c) shows that a QR code is then created for each multimedia content web page for the students to point and access the teaching material wirelessly on a scenic spot. Finally, the finished web page will be as shown in Fig.4(d).

Fig. 5 is the snapshot of AR View User Interface on the mobile device. The radar illustration in the upper screen denotes the scatter of attractions whose distances to the user are within 100 meters. The system achieves AR effect by overlaying attractions' 2D icons with live video captured from users' viewpoint. The tagging of attractions' 2D icons will constantly updated according to the change of users' viewpoint. When an attraction is right in front of the view of users, the system would then draw an arrow directing to the attraction's 2D icon to remind users.

(a) The field trip map

(b) Manage multimedia content online

(c) QR code for each teaching web page

(d) The teaching material web page

Fig. 4. Teaching material management module function diagram

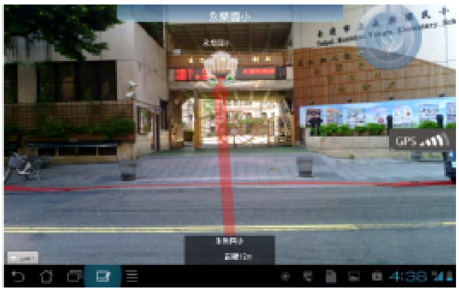

Fig. 5. AR View User Interface

In AR View user interface, a QR Code scanner button is implemented in the popup Toolbox menu on the lower left corner. If QR Codes appear near the spot of monument, then, just press QR Code scanner button on Toolbox menu to connect the website to retrieve the relevant multimedia context description as shown in Fig. 6. According to the course requirement, there are two types of QR Codes at each spot of monument. One for downloading the graphic description context of monument; and the other is to download pre-recorded video clips. Within the permitted time, students could repeatedly view the multimedia contents according their personal interests. Hereafter, the system would automatically download online quiz to enhance students' knowledge of respective monument, shown as Fig. 7. Upon completing the quizzes, other than displaying the outcomes on the mobile device's screen, the answers would be also uploaded to the website server for teachers to assess students' learning outcomes and adjust the course's scaffolding accordingly.

Besides, when the quiz is completed, system would automatically activate the camera module embedded in mobile device. Students could utilize the camera to take photographs or video of monument for future sharing with classmates.

Fig. 6. Multimedia Contents User Interface

Fig. 7. Online Quiz User Interface

V. Experiments and Discussion

In order to testify if HTT system could achieve the expected Scaffolding learning results, the study performs experiments on the sixth graders for two weeks. Experimental study architecture employs the process proposed by [7], shown as Fig. 8. Regarding the field trip teaching context, five famous monuments of Dadaocheng area, as shown in Fig. 9, in New Taipei City, Taiwan, were scheduled into the agenda of the course. The experiments are conducted in fixed POI attractions with variation on visiting routes.

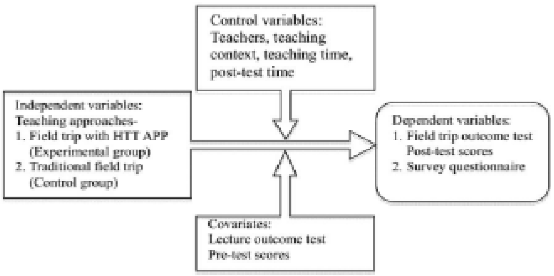

Fig. 8. The architecture of experiment

Fig. 9. Illustration of field-trip route

A class of 19 students participate in the experiment. Students are divided into two groups A and B to play the experimental group and control group in turn. Group A has 10 students while B has 9. The procedure of experiment is started with teacher lectures to all students in class, followed with a pre-test for 10 minutes. Field trip is then taking place with group B playing as the control group that uses the traditional approach while group A uses HTT system as the experimental group. Both groups are visiting the same monuments but with different routes to avoid the mutual interference during the field trip. Post-test is immediately taken place after the trip. The above procedure is repeated in the following week. This time, group B uses HTT system and group A is led by the traditional method. Finally, a survey questionnaire is taken to understand students' affection by different teaching approaches. Paired-sample t-test is conducted to further investigate the scores on pre-tests and post-tests and the analyzed results are shown in Table I.

Table I(a). Result of paired-sample t-test analysis for Week 1 test

Week 1 Test	Group A	Group B
Pre-test	(HTT) 14.20	(Trad.) 14.13
Post-test	(HTT) 16.80	(Trad.)16.38
Correlation Coefficient	0.439	0.951

Table I(b). Result of paired-sample t-test analysis for Week 2 test

Week 2 Test	Group A	Group B
Pre-test	(Trad.) 12.60	(HTT) 8.50
Post-test	(Trad.) 17.20	(HTT) 16.12
Correlation Coefficient	0.926	0.940

The experimental scenario of Table I(a) is, group A is led by an experienced teacher but HTT system is used for the field trip, while the guiding teacher of group B is a young and novice teacher who is responsible for narrating the whole trip. According to Table I(a), the average scores of group A are just promoted to 16.80 from 14.20 with correlation coefficient value 0.439. The lower correlation coefficient value implies students of group A do not rely too much on the HTT system during the trip. On the other hands, although the average scores of group B has similar increased rate to group A, its correlation coefficient value has climbed up to 0.951 which means students all depend upon the teacher to explain the history of each monument.

The experimental scenario of Table I(b) is to switch the field trip methods between groups A and B. This time, group A uses traditional narrating approach while group B adopts HTT system. Table I(b) shows that, after recovering back to the traditional field trip from HTT system, the correlation coefficient value of group A has climbed up to 0.926 in Table I(b) from 0.439 of Table I(a). Furthermore, its average scores increased rate in week 2 is also larger than week 1. It reveals that an experienced teacher can also play an effective role of learning scaffolding without the help of HTT system. On the contrary, although group B's correlation coefficient values of week 1 and week 2 are very similar, its average score is significantly increased from 8.5 to 16.12 in week 2. Compared with week 1, the result of group B shows that HTT system is a very helpful scaffolding tool for the novice young teacher.

After completing the experiments, each student is asked to fill out the survey questionnaire. It majorly asks students to express their subjective feeling about the traditional field trip teaching and HTT system individually. There are total 10 quizzes as:

- Questions No. 1-4 & No. 5-8 are control questions to check students' subjective learning experiences between the traditional narrating method and HTT system.
- Students then are asked to express their own preferred teaching method at Question No. 9.
- Question No. 10 is to check if students' self-learning intention could be promoted by HTT system.
- Questionnaire analysis results reveal that students all agree multimedia contents can attract their attention and stimulate their learning interests, and even further promote their self-learning desire after class. In addition, all students agree that HTT system positively can solve the problems which teacher can't meet individual student's curiosity during the group teaching.

Over the repeated discussions, the final conclusions are then made. First, the HTT system has limited help for the experienced teacher, but, on the other hand, it has significant assistance to the novice teacher. The second is the network environment will also affect the result of the experiments. 3G wireless bandwidth is insufficient during the week 1 experiment. However, the problem is solved before the week 2 experiment was conducted. Hence, students have more enjoyable experiences of viewing the multimedia contents during week 2. The third is multimedia contents shouldn't increase student's learning burden; especially during the outside-campus field trip noisy surroundings. Therefore, each multimedia video should be no longer than couple minutes for students' quick glance.

VI. Conclusion and Future Works

The paper presents an attempt of designing an AR-based M-learning platform for the local culture courses. Its design tries to match the main technology trends of M-learning, including location-aware learning, context-aware ubiquitous learning, and AR technology on mobile devices. It also explores the possibility to combine scaffolding learning with AR technique for M-learning system. Experiments show that, HTT system has obviously significant assistance to novice teachers on the field trip of local culture course. Students can more enjoy the video clips and multimedia contents of monuments during the field trip exploration.

However, the multimedia contents for AR interface is 2D icons at this moment. It is strongly believed that, if the 3D model of monuments can be recreated and overlaid at their original spots, the learning outcome and scaffolding effect can be further boosted. Hence, the next step of HTT system is to add image processing technique to register user to the landscape so that the disappeared monuments can be reconstructed by 3D graphical model.

In all, the HTT system achieves the effect of learning through play. HTT system also achieves one-to-one tutoring result. It solves the problem of preventing from the distraction in the traditional group teaching and field trip exploration. The experiments validate that HTT system can effectively boost students' interest for further self-learning to meet the goal of scaffolding learning.

Acknowledgment

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三、　活動照片

圖 1、與 Yuichi Ono 教授合影於報到處

圖 2、LTLE-1 發表情形

圖 3、LTLE-2 發表成員合影

圖 4、LTLE-3 發表情形

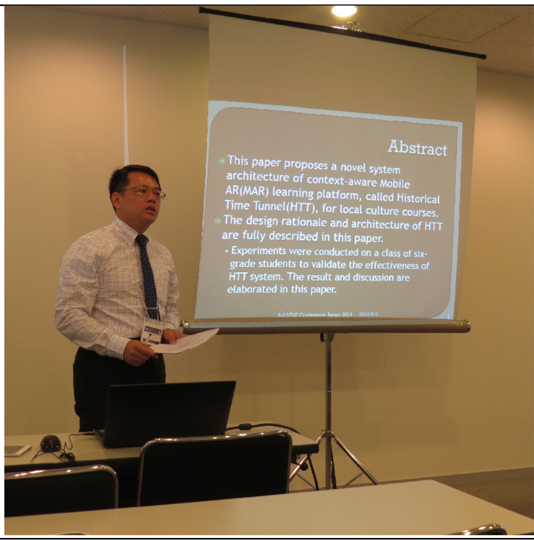

圖 5、LTLE-4 發表情形

圖 6、LTLE-5 發表情形

圖 7、LTLE-6 發表情形