Application of the Living Lab Concept: Empirical Validation in Taiwan's Minsheng Community

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Abstract: Starting in 2009, the Institute for Information Industry (III) began implementing empirical Living Lab applications in different locations throughout the Minsheng Community, Songshan District that targeted different user groups. These applications included the Future Classroom and Green Life Ecological Tourguide, which targeted junior high school students; ComCare, which targeted the elderly residents of the community; In-Snergy, which targeted large buildings; and inMedia_Kiosks, which targeted the general public. There are three main contributions to this study. First, it provides complete solution to technological service enterprises. Secondly, the Living Lab improves partnership relations with local residents. Thirdly, it enables Taiwan to establish close links and conduct knowledge exchange with Living Lab projects around the world.

Keywords: Minsheng Community; Living Lab; ComCare; In-Snergy; inMedia_Kiosks; Future Classroom; Green Life Ecological Tourguide

1. Introduction

Today's flourishing information technology has fostered the emergence of a knowledge society and fueled the development of innovative models. Technological innovation is no longer the exclusive domain of a small number of experts or scientists; nearly everyone can try their hand at technological innovation in the 21st century and serve as the ultimate arbiter in life, at work, and in society. While information technology was once geared primarily toward technology, controlled by research personnel, and mostly limited to the laboratory, technological innovation is now gradually escaping the confines of a laboratory, and research personnel are no longer limited to consisting exclusively of scientists, but increasingly include front-line users working in demonstration areas made up of people from communities and society at large. Research personnel are investigating users' real lives outside of the laboratory, and practical application and testing of new innovative models by users has become a key constituent of the product and service innovation process. The Living Lab concept is the result of this type of innovation model.

The Living Lab concept was originally proposed by MIT professor William Mitchell [1], who believed that a Living Lab is "a research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real life contexts," and brings the experiment environment of the laboratory into users' real living environments for the purpose of validation. Europe has led the world in promoting a Living Lab culture, including such efforts as the EU-supported Living Lab Europe project, Finland's establishment of the Open Living Labs – European Network of Living Labs (ENoLL) in 2006, and the current Living Labs Global organization headquartered in Spain.

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European technical innovation organizations have taken advantage of ENoLL to embark on a closely coordinated R&D campaign, and the founding members of this effort consisted of 19 living labs. A second group of members were selected in 2007, boosting the total number of ENoLL members to 32. When a third group of members was selected in 2008, 78 living labs were chosen out of roughly 130 applicants. The Taiwan Living Lab, which is centered on the Minsheng Community in Taipei's Songshan District, formally became an ENoLL member in 2008. The first and second groups of ENoLL members all consist of living lab organizations in Europe. Following the promotion and extension of the Living Lab R&D concept, the third group of ENoLL members also included ten non-European living labs in addition to 68 European living labs. These non-European members are located in Taiwan (2), China (1), Brazil (4), South Africa (2), and Mozambique (1). Apart from the two living labs in Taiwan, the remaining non-European living labs are all partners of EU FP6 or FP7 research projects.

In recent years, the European Union has employed innovative user-centric and vision-oriented technologies to achieve R&D and industrial development objectives in its information and communications development projects. These projects emphasize open, innovative environments that enable user interaction, and have led to the creation of a network of living labs in various European countries, which has served as a key platform for the promotion of innovative service platforms. ENoLL's goal is to provide companies and innovative products and services with an experimental platform for testing the implementation of new technologies in communities, schools, public places, government agencies, organizations, and entire cities, towns, and urban areas, allowing users in actual living environments, such as urban residents, working people, students, travelers, and consumers, to participate in technology testing work while simultaneously facilitating user-centric development of new technologies.

In order to realize this innovative model, the Living Lab concept is employed to extend the conventional simulated environments found in the laboratory to experimental environments in the real world. Living labs can be small residential communities, urban districts, or even whole cities. The public sector, research organizations, and corporate units can jointly participate in this kind of real world experimental environment. The testing of innovative service models in living labs allows researchers to obtain genuine feedback concerning actual products and services from end users. Meanwhile, end users can also help in the development to steadily improve the design and quality of these products or services, thereby meeting product or service extension requirements.

In this article, the Institute for Information Industry (III) shares experiences in building Living Lab services: Comcare, Future classroom, inMedia_Kiosks, Green Life Ecological Tourguide and In-Snergy in the Minsheng Community.

2. The Minsheng Community Living Lab

Although the Minsheng Community represents one of the Taipei's older and more established areas, after over forty years of development, the community is now quite comfortable, has a full range of amenities, and boasts a large amount of landscaped parks. The community largely consists of medium and high-density residential areas that house more than 50,000 residents. Public facilities within the Minsheng Community include post offices, banks, swimming pools, tennis courts, baseball fields, and parking facilities. The Minsheng Community Development Association was founded in 1993 at the request of over 30 community residents, including Ou Ching-hsiung. With the assistance of neighborhood and borough chiefs in the community, the Association offers classes in culture and the arts, and has worked with the city government to promote environmental protection, landscaping, and beautification. The community contains 25 parks of various sizes, and vegetated land accounts for one-tenth of the area of the community as a whole. Therefore, the entire community has a very green and shady appearance. There are two public high schools and six public elementary schools. In addition, Taipei Jiankang Elementary School (the first elementary school with an open campus in Taipei) and Taipei Xisong High School (a community high school) are located just outside of the community. Buses are the chief means of transportation within the Minsheng Community, and bus routes follow the main roads within and along the periphery of the community.

Starting in 2009, III began implementing empirical living lab applications in different locations throughout the Minsheng Community that targeted different user groups. These applications, listed in Table 1, included the Future classroom and Green Life Ecological Tourguide, which targeted junior high school students; ComCare, which targeted the elderly residents of the community; In-Snergy, which targeted large buildings; and inMedia_Kiosks, which targeted the general public. These empirical application projects have enabled Taiwan to establish close links and conduct interchange with the development of international living labs.

Table 1. Overview of empirical projects.

Application project	Location	Users	Time	Quantity
ComCare	Families in the Songshan District	Songshan District residents over 50 years of age	From January 2010 to the present	Equipment installed at 325 locations; 239 persons completed questionnaire
Future classroom	Minsheng Junior High School	7th and 8th grade students, 10 teachers	From June 2010 to the present	370 persons
inMedia_Kiosks	Songshan District Public Office, railway station, sports center, Cultural & Creativity Park, Puppetry Art Center of Taipei, and Taipei International Flora Expo	General public	From June 2010 to the present	17 outdoor intelligent interactive inMedia_Kiosks
Green Life Ecological Tourguide	Minquan Park, Xinzhong Park, and Fumin Ecological Park	Students and parents	From July 2011 to the present	Two sessions, a total of 64 trainees recruited
In-Snergy	Minsheng Technology Building, 7-11 Guangfu store	Building users, convenience store	From 2009 to the present	23 stores, 400 families

2.1 ComCare

Songshan District, encompassing the Minsheng community, was the earliest commercial area of Taipei, and residents have a high level of community consciousness. As of the end of November 2011, the Songshan District contained 78,738 households and had a total population of 209,757. The district's male to female ratio was 0.9:1 [2]. Furthermore, according to the report of the Songshan District Healthy City Development Project [3], the district has an aging demographic structure in which children and youths, middle-aged persons, and the elderly account for 17.92%, 70.18%, and 11.9% of the population, respectively, which satisfies the WHO's definition of an aging population. (The United Nations World Health Organization defines an aging country as one in which persons aged 65 and over account for at least 7% of the entire population.) The district's natural population growth rate is 2.49%, which is less than the Greater Taipei City average growth rate of 2.72%. The district contains abundant healthcare resources, including a total of 265 hospitals and clinics. It has consistently striven to improve residents' quality of life, has vigorously implemented measures that improve community health, and has embraced a vision of "Lifestyles of Health and Sustainability in Songshan" [4].

During our investigation of users' needs, we found that elderly persons in Songshan District had two main needs:

1. Because most elderly persons in Songshan District are able to manage their own affairs and live independently, they have health self-management needs. Unfortunately, modern high-tech products are often not designed for use by seniors, and they have many features that may discourage use by the elderly, such as tiny fonts and complex functions/interfaces. Because of this, there is currently a lack of effective tools that can be used by seniors for health self-management.
2. Due to physical infirmity, lack of companionship, and psychological changes, seniors may experience social isolation, which can be accompanied by loneliness, reclusiveness, and alienation. As a result, seniors frequently long for mental and spiritual satisfaction and support.

ComCare is an application used on seniors' smart mobile devices to monitor their health and also see to psychological needs. It was introduced in January 2010. In accordance with the "service experience engineering" methodology developed by III's Innovative DigiTech-Enabled Applications & Services Institute (IDEAS), work during the first year consisted chiefly of analysis of operating environment characteristics and proof-of-concept (PoC). This research sought to understand seniors' needs and establish a humane, intelligent healthcare service. The main tasks during this stage consisted of developing the service platform software (including UI and operating procedure design, and technical service function plan), procuring hardware, establishing service operation and maintenance mechanisms, and recruiting users.

A small-scale trial operation was performed with a focus group discussion at the end of 2010. Twenty seniors were invited to use the ComCare services at this event on a trial-basis, and feedback from these individuals was used as a basis for the improvement and debugging of the services. Proof-of-service tasks were performed during the second year (2011). Deployment of on-site service devices began during January 2011; as of now, a total of 325 devices have been deployed at empirical testing sites throughout the Songshan District, and new services are continually being developed and added. In addition, following deployment of the empirical testing cloud data management platform, users' usage has been successfully recorded, and the system has continued to update dynamic empirical data in a database that will be used to conduct subsequent empirical analysis. Service introduction steps have generally relied on the development and integration of service systems by commercial partners, and the recruiting of trial users has been carried out with assistance from the local competent authority (Songshan District Office).

ComCare currently offers 14 main functions which address seniors' everyday needs; of these, there are nine chief social behavior functions, including 'community', 'add friend', 'video', 'photo album', 'games', 'bulletin board', 'calendar', 'weather forecast', and 'I am a Songshan resident'. There are also five health management-related functions, including 'food', 'exercise', 'blood pressure/heart rate', 'height/weight', and 'statistical data' (see Figure 1). In addition, there are a total of 38 various sub-functions. Table 2 contains a list of all functions.

Figure 1. Block diagram of ComCare functions.

Table 2. ComCare functions.

Social behavior functions			
	Main functions		Sub-functions
I	Community	1	Select everyday product advertisement
		2	Select the newest deal
		3	Select restaurant /snack
		4	Select course activity advertisement
		5	Select snack advertisement
		6	Select coffee advertisement
		7	Select clothing advertisement
		8	Select 3C product advertisement
		9	Select bread/pastry advertisement
II	Add friend		
III	Video Interaction		
IV	Photo sharing	10	View my favorite photo album
		11	View friend's photo album
V	Enter game area	12	Games- Sudoku
		13	Games -Turn over chess
		14	Games - Spot the differences
		15	Games - Night Market Guru
		16	Games - mahjong
		17	Games - baccarat
VI	Multimedia calendar	18	Add text calendar
		19	Add upload voice calendar
		20	Edit text calendar
		21	Edit upload voice calendar
		22	Delete calendar
VII	Query weather forecast		
VIII	Enter community bulletin board		
IX	I am a Songshan resident		

Health management functions			
	Main functions		Sub-functions
X	Diet management	23	Add dietary data
XI	Exercise management	24	Add exercise data
XII	Blood pressure/heart rate management	25	Add systolic pressure data
		26	Add diastolic pressure data
		27	Add heart rate data
XIII	height/weight	28	Add body weight data
		29	Add height data
		30	Add BMI data
XIV	Statistical data functions	31	Query height / body weight data table
		32	Query height / body weight data chart
		33	Query diet data table
		34	Query food data chart
		35	Query blood pressure / heart rate data table
		36	Query blood pressure / heart rate data chart
		37	Query exercise data table
		38	Query exercise data chart

2.2 Future Classroom

The Future Classroom is in Minsheng Junior High School, which is located in the Minsheng Community. Since implementation was initiated in June 2010, the experiment has, to date, included ten classes of seventh-grade students during the 2010 school year, and 11 classes of eighth-grade students during the 2011 school year. Ten teachers (full-time course instructors) participated, and the classroom was used in ten courses, including English, social studies, Chinese, information technology, guidance, and school-based curriculum (SBC). Students and teachers participating in empirical testing spent several hours of classroom time each week, and data recording and collection was performed during instructional time to provide information for subsequent analysis and application.

The realization of the Future Classroom concept required both hardware facilities and software services. The hardware portion includes a digital whiteboard (this experiment used a 52" back-projection digital whiteboard), a touch-screen computer, learning devices, small notebook computers, digital pens, e-books, e-podiums, and wireless network switches; the software portion includes an e-learning cloud computing platform, online television (IPTV), and digital teaching materials. The Innovative Green Cloud-based education software Services system (IGCS) developed by the III Digital Education Institute has provided classroom teaching and learning services since 2009, and has been adopted in the connected classroom at Minsheng Junior High School in response to the small group-teaching concept of the school's connected classroom. Taking English as an example, existing classroom equipment (i.e., wireless network, all-in-one group teaching computer, digital whiteboard, and the teacher's notebook computer) is used in conjunction with the teaching service platform as instructional tools. Assistance from the teaching service platform has enhanced the students' English abilities and enabled experiments and research on a number of topics, such as whether e-learning can boost students' learning motivation and learning interest. Apart from all-in-one computers, students also use new tablet computers. During the 2011 school year, specialized classrooms were planned which utilized an interactive teaching environment employing one "e-schoolbag" per person; students used tablet computers and teachers employed digital whiteboards in conjunction with e-desks and wireless network switches. This setup made high-tech instruction more convenient and classroom interaction more fluid and immediate. This concept is illustrated in Figure 2.

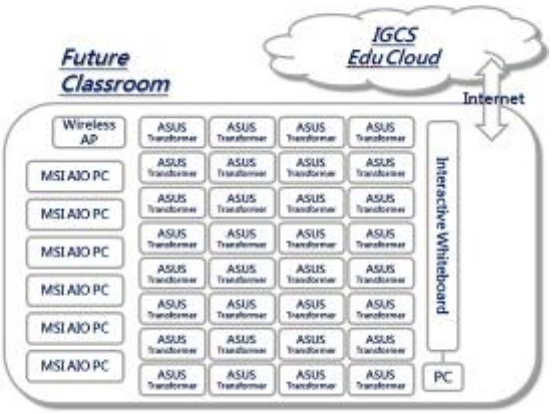

Figure 2. Future classroom concept.

During the course of the actual experiment, three participating English teachers developed three e-schoolbag English teaching models, which were administered to seventh and eighth-grade students. Students in three classes participated in the four-week experiment course, and 105 feedback reports from students and teachers subsequently revealed a high level of enthusiasm for the approach. The e-schoolbag teaching activities improved on the conventional one-to-many unidirectional teaching model of the past, and classroom observations revealed that students participated actively and paid more attention. The interactive teaching approach using the digital whiteboard ensured that all learners could have the opportunity to participate actively, and an appropriate balance was struck with regard to technology use [5]. Apart from English instruction, a geography class also employed a similar teaching approach with equal success. The geography class chiefly relied on the digital whiteboard, IGCS teaching service platform, and all-in-one PCs to teach ten classes of seventh-grade students; the 640 hours of instruction over the course of four weeks was highly praised by more than 50 of the participating students [6].

As for the project's extension approach, the Future Classroom was chiefly equipped with all-in-one PCs and tablet computers from the III and sponsoring firms, and these items were used in conjunction with the school's existing hardware and software. Instructional software consisted of the III-developed IGCS cloud system, and III assisted with hardware and software adoption and integration. With support from the Minsheng Junior High School’s principal for ICT-aided instruction, school policies encouraged and assisted the experiment. In addition, teachers maintained a positive attitude toward the new teaching methods and were willing to produce or adjust teaching materials when necessary to ensure success.

2.3 inMedia_Kiosk

Large billboards have come to play a significant role in public life in recent years and are commonly seen in public areas such as stations and airports, buses, large buildings, convenience stores, food courts, sports arenas, and hospitals and clinics. In spite of this, no comprehensive business model has yet been developed to achieve a win-win outcome with advertisers and on-site marketers wishing to share the use of these billboards through the adoption of interactive services. This project has sought to validate interactive intelligent inMedia_Kiosk services in an empirical testing context. The experiment used inMedia_Kiosks to provide "localized real-time information," "interactive touch-control services," and "value-added integrated marketing service," and revised service content and service models on the basis of user experience data in order to increase the number of persons using the services. An increase in the number of persons experiencing the billboard messages is the only way to validate the billboard service operating model, and can generate greater crowds in areas with billboards to enhance actual derivative benefits. The Living Lab Project has installed 17 intelligent interactive inMedia_Kiosks at outdoor locations including the Songshan District Office, Songshan Railway Station, Songshan Sports Center, Songshan Cultural & Creativity Park, and the Puppetry Art Center of Taipei. In addition, the project also installed ten intelligent interactive inMedia_Kiosks during the Taipei International Flora Expo which elicited an enthusiastic response from members of the public. It is hoped that this empirical project will gauge the public's acceptance of intelligent interactive inMedia_Kiosks and help generate potential recommendations for achieving an intelligent, convenient metropolis. The empirical testing period has been underway since June 2010, and all members of the public are welcome to participate.

2.4 Green Life Ecological Tourguide

The Minsheng Community has the greatest percentage of green space of any community in Taipei. Apart from its large vegetated area, the community is also rich in ecological resources. Taking Fumin Ecological Park as an example, this park was built around an old drainage canal, and it is one of the few parks in Taipei to contain aquatic ecology. Apart from the ordinary function of providing a place for leisure and recreation, this park also possesses plentiful ecological education resources, and its nearly 100 meters of ecological waterways captures the essence of a natural stream. As a result, the park is a popular ecological teaching site for many elementary schools. Apart from school fieldtrips to the park, every year 1,000 interested members of the public in nearly one hundred groups go out into the community to act as ecological guides through arrangements made by the district public office and other relevant associations.

After visiting with Deputy District Chief Chan Tien-pao, Trail Association lecturer Lu Hsi-lai, Community College Director Tsai Su-chen, Dongrong Borough Chief Cheng Yu-mei, and Fujin Borough Chief Wang Wen-fu at the district public office, the research team found that a shortage of lecturers had forced the district to adopt a reservation system, and many groups have to make reservations several months in advance to be sure of getting a guide. At the same time, the park's fixed-time, fixed-location guide approach was also unsuitable for persons visiting at unscheduled times, thereby limiting the amount of people receiving guided services among the general public. Furthermore, the use of human guides also limited tour routes and content, prevented the rapid development of new routes, and hampered the updating of interpretive content reflecting changes in the environment.

After holding talks with the district office, project personnel recommended the use of an automated guide service using iPhones to resolve problems caused by the use of conventional human guides. At the same time, observation of user responses would be employed to determine whether the operating model was successful so that successful experiences could be replicated in other areas.

Minquan Park, Xinzhong Park, and Fumin Ecological Park were chosen as the initial sites for this experiment in the community. On one hand, the project sought to link all three parks into a single guided trail taking approximately one hour to walk, which would include route, time, and physical ability requirements in line with the majority of ordinary visitors. On the other hand, the project also sought to take advantage of the differences in education and unique scenery in each of the three parks, all of which contain distinctive plant life, which was why the three parks were originally chosen to demonstrate the system in the first place. While the project's long-term goal is to serve students, families, groups interested in plant ecology and environmental protection, and domestic and foreign tourists, the project initially focused primarily on young students and their parents in light of the current limited funding. The project therefore arranged outdoor instruction in order to observe users and validate the system. The iPhone was selected as the system interface because it has the greatest market share of any smart phone in Taiwan.

After confirming the test sites and target user groups, the project embarked on application planning and design. After numerous rounds of discussion and revision, the resulting App, known as "Mobile Green Living", officially went online in July 2011. Because park management is the responsibility of the Taipei City Government, the district public office, and the borough chief, project personnel visited these relevant units during the design and planning stage. It was found that reaching a joint consensus is extremely important; local experiments cannot proceed effectively without the support and consent of relevant management units. After support for and acknowledgment of the experimental plan had been obtained, the project then invited experts from the Trail Association to select and establish various ecological points of interest. The parks contain a wealth of plants ecology, but because most users only have approximately one hour to spend, we had to select the most distinctive plants—or those possessing special local significance—to be highlighted in the project. This part of the project therefore required two months of research and discussion, and proposals had to be confirmed by the borough chiefs before being finalized.

After determining the various points of interest, the project began designing an App for use in conjunction with Google Maps. As described previously, design of the App interface had to take into consideration the fact that users would consist of young students. At the same time, the research team also had to perform on-site testing of the user interface and its various functions, and six revisions were required before the researchers settled on a final version. In conjunction with its emphasis on personal experience, the project designed a summer camp route focused on the topic of environmental protection. By integrating other personal experience courses, an itinerary suitable for one-day family activities was designed for the App using a "teacher-led format" to simulate a future self-guided approach.

2.5 Intelligent power consumption

One of the most importance issues of sustainability is energy. One of the initial attempts to express human impact mathematically was developed by Ehrlich and Holden [7]. This formulation attempts to explain human impact, I, in terms of three variables: population p, affluence a, and technology efficiency t: I = f(p, a, t); where population, measured by capita, is a variable that is increasing. Affluence, measured by consumption per capita, is a variable that almost all forms of economic theory aims to increase [8]. If the rate of decrease for technology efficiency, measured by impact per unit consumption, is not less than the combined increasing rate of p and a, then the impact I becomes increasing and our impact cannot be sustainable. In addition, technology efficiency in the energy context is more of topic for electro-mechanical-chemical-physical-material research. So what role does information communication technology (ICT) have? The formula can be reformulated as: I = g(p, w, m, t); where the affluence is viewed differently and is decomposed into awareness, w, and market-exchange, m. Awareness, measured by demand per capita, is the view of human behavior effectiveness analogous to technology efficiency. There have been many variants of environmentalism directly looking at our demands, and reflecting on the effects of our demands. Today these movements are spread faster than before with the proliferation of the Internet. Market exchange, measured by consumption per demand, as with the case, and many web services reduces the redundancy in various markets' exchange mechanisms.

Awareness is gained by sufficient communication of necessary information to users. Market-exchange efficiency is achieved with necessary communication of sufficient information between users. Therefore, we aim to investigate the potential of ICT for minimizing the contributions from variables w and m in the context of energy consumption that is inherently user-oriented and must be studied across multi-disciplinary perspectives.

The "In-Snergy Intelligent Cloud Green Energy Management System," which was developed at III and is a recipient of the R&D 100 Award, has been undergoing testing at the Minsheng Technology Building since 2009. After more than a year of testing, the system was found to have reduced power consumption by approximately 27% compared with the same period of the previous year. Aside from the Minsheng Technology Building, the system is also currently being tested at six 7-11 stores throughout Taiwan, AU Optronics' Taichung plant, the Naruwan Hotel, and the Farglory Sanxia Senior Housing Project. The use of this system is very convenient for ordinary household users and provides substantial economic benefits. Approximately NT$2,000 is all that is required to install the intelligent cloud green energy management system, which allows devices ranging from cell phones to computers to serve as electricity control panels and enables users to employ their cell phones and computers to directly connect to the network and control household appliances while outside of the house.

3. Empirical Design of Minsheng Community Living Lab

In order to achieve the goals of the Living Lab concept, a user-driven open innovation model is adopted. This model allows users to be innovators, and ensures that the new product cycle can continue without interruption in a living lab project. Researchers can then continuously improve the content of innovative products and services under real-world conditions. The foundations of the III are rooted in innovation, social concern, and practical aspects. We design comprehensive service blueprints, select service user groups, and design various experiments intended to assess the performance of technical services that assist domestic firms in the testing of service concepts and implementation of PoC, PoS, and PoB projects. This reduces risks associated with a lack of adequate market understanding and simultaneously increases the chances of achieving success among technological service enterprises.

3.1 ComCare

When selecting test users for ComCare for seniors, we looked for persons meeting the following two conditions: (1) persons over 50 years of age with a registered household in, and who actually live in, Songshan District; (2) wireless Internet access in the person's household; and a wireless network in the household. Users were chiefly recruited with the assistance of the district office. III produced small recruiting posters, and had borough directors notify all borough staff concerning the recruiting of ComCare users during their regular meetings. The III also requested borough directors to notify borough chiefs and ask the borough chiefs to explain the program to residents. Thanks to the influence of borough chiefs and borough directors in the community, many residents signed up to use ComCare. Furthermore, the district office provided a list of users, and asked us to hold explanatory meetings for users considering signing use agreements.

Participants were notified upon signing the use agreement that their user data would be provided to this unit for research purposes. Furthermore, in order to collect information on the test users of the service, we asked users to use ComCare at least twice each week. A user behavior analysis team consisting of invited experts in information science, sociology, psychology, and other relevant sciences was also set up. This team bore responsibility for determining service industry needs, service performance, and user behavior analysis methodologies and platforms. To date, a total of 325 Songshan residents have signed up to use the ComCare services.

Two main data collection methods have been employed: (1) The test data management platform has been used to obtain a record of each function used by each user from the start of service until the present, and an abundant amount of feedback information has been collected. Analysis of function log records has enabled a better understanding of test users' service use behavioral models. Furthermore, a ComCare customer service window has been established to provide consulting services at all times and gather test users' views and feedback. (2) Twelve questionnaire tea parties were held in November 2011, and all ComCare users were invited to attend these events and complete a questionnaire survey. The tea parties were also used to provide instruction regarding the use of ComCare and help users gain a better understanding of new ways to operate the service. When seniors were unable to attend the parties, we sent survey personnel to administer the questionnaire at their homes, and a total of 239 valid questionnaires were recovered. The questionnaire was a structured questionnaire compiled by a team of experts, and its content included basic user information and users' impressions of ComCare service (including information quality, service quality, ComCare self-efficacy, and perceived risk). In order to prevent users from giving noncommittal responses, as well as to make user responses more easily measurable, a six-item Likert scale with six choices for each dimension was used (see Table 3 for a sample portion of the questionnaire); the higher the score for each item, the greater the respondent's satisfaction with that service. Analysis focused on the data platform data and questionnaire data for the 239 test users who completed the questionnaire.

3.2 Future classroom

The project called for the Living Lab innovative service model to be used to investigate user impressions and system performance while the IGCS teaching service platform was actually in use. If the IGCS platform could be employed by all teachers and students in a school for technological instruction, this would allow the most genuine feedback concerning the platform and technology to be obtained from users regarding the roll-out experience. With this in mind, three teachers at Minsheng Junior High School were arranged to cooperate with the project by using the platform with the technological instruction content knowledge proposed by Mishra and Koehler (Technological Pedagogical Content Knowledge (TPCK)) serving as a framework. The three elements of technology, construction, and content were used to design a teaching plan conforming to instructional needs and allowing successful teaching [9]. The study design called for teachers to use the IGCS teaching service platform and adopt collaborative learning strategies in three teaching models: an English grammar teaching model, English vocabulary teaching model, and English reading teaching model. Two classes were then selected for each of the three teaching models to serve research subjects, where one class served as the experimental group and the other class served as a control group. A total of six classes containing 184 students received instruction using the IGCS teaching platform. After a pretest, it was arranged for the experimental group to receive technological instruction in the "connected classroom," while the control group attended a conventional class in an ordinary classroom. After one week of instruction, analysis of the pretest and post-test results, open interviews, and classroom observation records was employed to assess overall performance.

Table 3. Example from the questionnaire.

Item	Question	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
1	I can immediately obtain needed information from ComCare						
2	As far as I am concerned, ComCare is a good source of correct information						
3	The ComCare provider unit can provide services on time as promised	1	2	3	4	5	6
4	Using ComCare doesn't require too much mental effort						
5	I feel that ComCare's game functions are very handy						
6	If I used ComCare, online hackers might steal my account number						

The subjects in this experiment consisted of 184 seventh-grade students, with ages of 13–14 years, at Minsheng Junior High School. The teachers relied on the results of the pretest to familiarize themselves with each student's English ability prior to the experiment, and had prior experience in using the teaching service platform to design practice activities. In the classroom, the teachers conducted instruction and activities using an electronic whiteboard and group-distributed all-in-one PCs and/or tablet computers.

This study used the IGCS teaching service platform developed at the III Digital Education Institute as the primary activity tool. IGCS provides five activity templates for sentence rearrangement, article rearrangement, picture and text matching, picture viewing combined with fill in the blank questions, and crossword puzzles. The platform also allows teachers to design activity content based on instructional goals, and an "assign" function can assign activities to each student group. After each group of students has logged on to the platform via WiFi, they will simultaneously receive the activities, and the teacher can also use a "monitoring" function to track each group's progress and results. This allows the teacher to monitor student learning progress in real-time, review each group's errors, and make timely adjustments to his or her teaching strategy. During the initial period of the experiment, the students employed six MSI 20" touch-control all-in-one PCs as group learning tools, and a team instructional model was implemented in conjunction with collaborative learning activities. In order to further boost students' classroom participation and learning effectiveness, this study also employed 36 Asus EeePad Transformers, and gradually had the teachers apply IGCS instructional tools, such as quantitative feedback, assessment testing, and remedial instruction function modules, in classroom instruction in order to fine-tune instructional content and interaction methods.

Performance assessment tools include the "achievement assessment test," "technological instruction satisfaction scale," "teacher interview outline," and "student interviews outline." Depending on the teaching model, achievement assessment testing may take the form of the "junior high English grammar achievement assessment test," "junior high English vocabulary achievement assessment test," and "junior high English reading achievement assessment test." The three achievement assessment tests were formulated by the three teachers participating in the experiment to include 30 questions drafted after referencing the standard junior high school test question bank. The questions were reviewed by two advisory committees, and inappropriate questions were eliminated. Afterwards, the tests were administered to three classes of seventh and eighth grade students who had not participated in the experiment as a pretest, with one test being given to each class.

1. Pretest (10 min): The pretest was administered using pen and paper, and the questions included picture-viewing combined with fill in the blank questions and vocabulary spelling sections.
2. Grouping: Students were assigned heterogeneously to six groups of six persons each on the basis of their pretest scores. When the students entered the classroom, they sat together with the other members of the group in order to facilitate interaction and discussion.
3. Whiteboard instruction (15 min): The summer activity topics were "holidays" and "fruit", and the teacher used an electronic whiteboard to present the content of the teaching materials and teach spelling and use of holiday-related terms.
4. Experimental activity (10 min): After completing the teaching content, the students performed the "holiday picture and text matching" and "vocabulary rearrangement" practice activities, with each activity taking 5 minutes. "Holiday picture and text matching" required that the students correctly match the holiday names with the corresponding images, while "vocabulary rearrangement" required re-arranging scattered vocabulary items into their correct location. After logging on to the instructional platform, the members of each group discussed and completed the questions, and the teacher could track each group's progress and answers in real-time.
5. Full-class discussion (10 min): The group that completed the questions first assigned one member to demonstrate the answers at the front of the classroom. Depending on the results of the activities, the teacher reviewed questions with relatively high error rates.
6. Post-test (10 min): A post-test was conducted after the activities and contained questions similar to those in the pretest but in a different order.
7. Open interviews: Interviews were conducted with the teachers and students randomly selected from each group. Each interview took approximately 5–10 minutes, and the interviewees were asked to describe and reflect on classroom interaction.

3.3 InMedia_Kiosk

The first stage of the research method consisted of cultivating consumers' habit of looking at inMedia_Kiosks, and then gradually incorporating advertising elements in order to achieve the profit-sharing objective of both partners. During the second stage, smart phones and other devices would be used to achieve interaction between consumers and billboards, ensuring the transmission of timely information and meeting the varied needs of different individuals at different times. To achieve these project objectives, the project team drafted the following "project management and planning" and "system development and deployment" strategies, and assigned implementation items to two stages as follows:

Project management and planning: Stage 1 and Stage 2 implementation items were as listed in Table 4 and Table 5 respectively

System development and deployment: Stage 1 and Stage 2 implementation items were as listed in Table 6 and Table 7 respectively.

The system will automatically record various types of user operating behavior, including number of clicks, use time, pause time, order of operation, and sequence of clicks. This data will be transferred to a data analysis platform for analysis of user behavior, which will guide subsequent optimization of service design.

Table 4. Project management implementation items during Stage 1.

Task	Content	Implementation method
Project management and coordination tasks	Establishment of a project team and implementation of communication and resource allocation in accordance with system, platform, and service pre-operation planning and coordination matters.	Regular assignment of personnel to hold project management coordination conferences confirm project implementation progress
System service process planning	Planning of the inMedia_Kiosk system and completion of system block diagram by the project team	The project team jointly carries out planning of inMedia_Kiosk service processes to provide a reference for subsequent development work
Data interaction platform planning	Planning of the data interaction platform and completion of system block diagram by the project team	The project team carries out planning of data interactive service processes to provide a reference for subsequent development work
Service information platform planning	Planning of the service information platform and completion of system block diagram by the project team	The project team carries out planning service information platform processes to provide a reference for subsequent development work
Content management platform planning	Planning of the content management platform and completion of system block diagram by the project team	The project team carries out planning of content management service processes to provide a reference for subsequent development work

Table 5. Project management implementation items during Stage 2.

Task	Content	Implementation method
Image identification system service process planning	Planning of the image identification system and completion of system block diagram by the project team and technology transferring firm	The project team carries out planning of image identification system service processes to provide a reference for subsequent development work
Cell phone interaction platform planning	Planning of the cell phone interaction platform and completion of system block diagram by the project team	The project team carries out planning of cell phone interactive service processes to provide a reference for subsequent development work
Cell phone payment platform planning	Planning of the cell phone payment platform and completion of system block diagram by the project team	The project team carries out planning of cell phone payment service processes to provide a reference for subsequent development work

Table 6. System development implementation items in Stage 1.

Task	Content	Implementation method
InMedia_Kiosk system program development	Completion of inMedia_Kiosk system development and deployment, including multimedia playing system and media analysis data feedback mechanism; development of maintenance and analytical functions, interface, etc.	Engineering personnel carry out relevant system program development tasks to accommodate planned processes
Content posting platform program development	Completion of digital content posting platform development and deployment tasks	Engineering personnel carry out relevant system program development tasks to accommodate planned processes
Content management platform development	Deployment and development of digital content management platform	Engineering personnel carry out relevant system program development tasks to accommodate planned processes
Data interoperability and linking program development	Completion of data interoperability mechanisms and linkage process program development tasks	Engineering personnel carry out relevant system program development tasks to accommodate planned processes
Service information platform development	Development of service information interface programs	Engineering personnel carry out relevant system program development tasks to accommodate planned processes
System integrated testing	Data streaming between systems, interface integration, and relevant testing tasks	Engineering personnel arrange system integrated testing focusing on the developed platforms and systems

Table 7. System development implementation items in Stage 2.

Task	Content	Implementation method
Broadcast management and operation	Implementation of digital issuance and consultation, and digital content introduction and integration tasks	Engineering personnel carry out relevant system program development tasks to accommodate planned processes
Cell phone interaction platform development	Deployment of a transmission platform to facilitate transmission of interactive services to users	Engineering personnel carry out relevant system program development tasks to accommodate planned processes
Cell phone payment platform development	Including design and development of mobile payment elements, establishment and transmission of security mechanisms, and other service element integration tasks	Engineering personnel carry out relevant system program development tasks to accommodate planned processes

Table 8. Example questionnaire section.

Item	Question	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
1	I can obtain the information I want from Mobile Green Living						
2	I can get even more interesting ecological education from the mobile guide service than from books						
3	I will try other ecological guide services using a cell phone in the future	1	2	3	4	5	6
4	Today's activities and game were very fun						
5	I would like to participate in other similar activities in the future						

3.4 Green Life Ecological Tourguide

To ensure the effective testing of this project, the degree of linkage between everyday life and the community and acceptance and use of mobile applications by families (especially parents) was considered when selecting test subjects; the higher the degree of the foregoing linkage, the more suitable the individual would be as a test subject for the project.

With these considerations in mind, this project first invited association members to serve as subjects, and also urged families to participate together in this summer camp learning activity. Because the III's R&D units are located in the Minsheng Community, and many III employees are highly conversant with online applications, project sign up was announced through the III employee benefits committee, and two sessions were held in 2011 on July 29 and August 3 respectively; a total of 64 trainees were recruited (in addition to another six parents participating as observers) for the summer camp activity.

This project sought chiefly to observe whether the use of a mobile client service could assist the extension of ecological education.

The goal of designing this activity from the very beginning was to create a program that was simultaneously fun and competitive for the children in order to boost their attention spans and, therefore, ability to learn new information. On-site activities included group question-and-answer sessions and ecological games. We further recorded whether there were any changes in the children's ecological knowledge before and after the activities as a result of the classroom sessions.

Many observers participated, including one teacher leading each group, two teaching assistants, and two accompanying work personnel. Everyone's on-site observations and records were compiled immediately after the conclusion of the activities, and discussion meetings were held to share views.

In addition, a questionnaire was designed to gather participants' opinions (Table 8). In view of the participating children's possibly limited expressive ability, this questionnaire was aimed chiefly at their parents. However, since many children's parents did not take part, it was found that getting parents to coax their children to express their opinions, allowing changes in the children's views of environmental protection and ecology before and after the activities to be determined, was an essential element. This project has strengthened this aspect of communication with parents, and hopes to obtain more authentic feedback in this way.

3.5 In-Snergy

The In-Snergy system developed by the III's Smart Network System Institute integrates developmental experiences and technology accumulated over the past few years, including those related to wireless communications, power lines, and cloud platforms. Data collected at the source by this system include equipment status, power use habits, and even power consumption. This system seeks to achieve the goals of transparency, precision, and standardization through the monitoring of user behavior and multi-level analysis and management. The system's key technologies include circuit identification, communications technology, and a highly reliable back-end management platform. The system is currently being tested at six 7-11 stores throughout

Taiwan, AU Optronics' Taichung plant, the Naruwan Hotel, and the Farglory Sanxia Senior Housing Project. Since In-Snergy is still being tested in several spots, and since data and analysis have not yet been conducted, it will not be discussed in the rest of the paper.

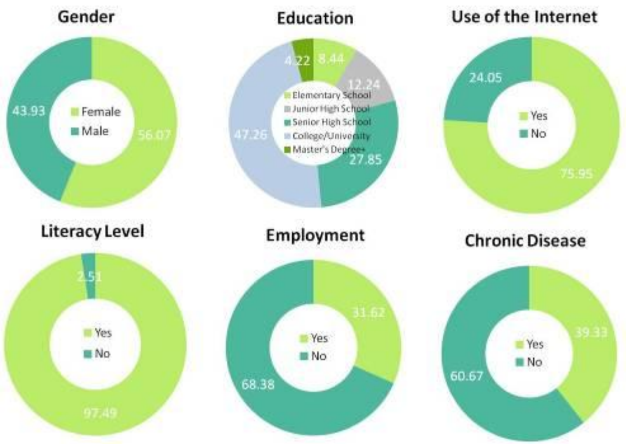

Figure 3. Basic background information of test users.

4. Results

4.1 ComCare

Questionnaire results indicate that the ages of test users ranged from 50 to 86, and the average age was 62 years (with a standard deviation of 8.22). Figure 3 presents basic information concerning ComCare users. Among the 239 test users, 56% were women and 44% were men. Users' educational levels were relatively high, and a majority had at least a university education. At least 75% of the respondents regularly used the Internet, which was higher than the finding of another survey of Internet use among the older generation that 56.3% of senior respondents had Internet experience [10]. Approximately 68% of users were retired or not currently employed, and close to 40% of users had a history of chronic disease (such as hypertension or diabetes) (Figure 3).

A total of 205,510 main function and sub-function usage records were made in user logs. The distribution of main function usage was as shown in Figure 4. Analysis revealed that test users used health management functions such as data queries, diet management, blood pressure management, and BMI management relatively frequently; all of these functions were used more than 5,000 times. This indicates that seniors in the Songshan District pay considerable attention to personal health management. It was also discovered at the ComCare tea parties that many test users had gotten in the habit of keeping regular health records, and made recommendations for improvement of health management service functions to this unit. In addition, some users even brought ComCare to their doctor's attention as a simple auxiliary diagnostic tool when going for hospital check-ups. The most commonly used social behavior function was "*Haokang Baobao*", a function that provides users with information on special offers for food, clothing, entertainment, and more, which indicates that the elderly pay close attention to special offers and customer advertising. In addition, there is research indicating that computer games have real benefits for the elderly, and can provide physical (hand-eye coordination, mental stimulation) and psychological exercise, and can also offer psychological support [11, 12]. Furthermore, in order to gain a better understanding of problems that currently popular games might pose for the elderly, the research team specially developed a series of games aimed at elderly ComCare users. Currently, these games are among seniors' favorites, and frequency of game use is gradually increasing (Figure 4).

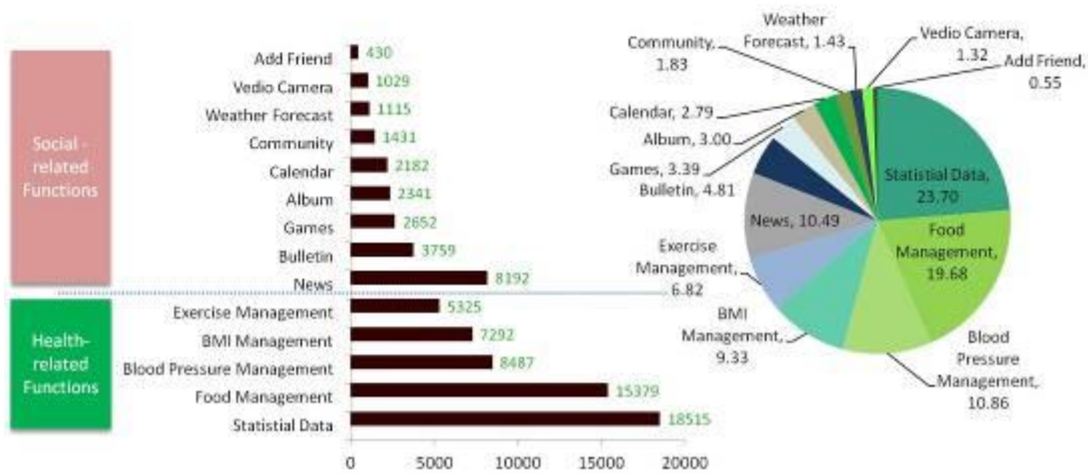

Figure 4. Usage instances and relative frequency for main ComCare functions. (Numbers of service function usage instances are from January 1 to December 9, 2011.)

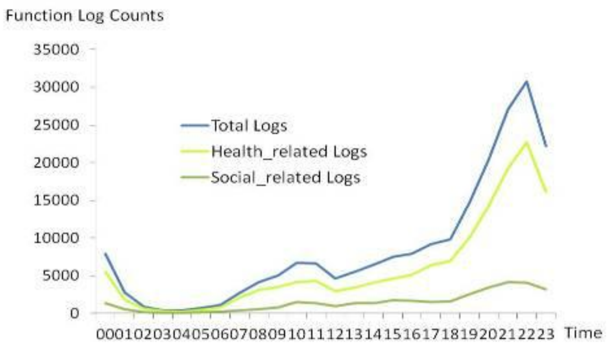

Figure 5. Service frequencies at different times of the day.

Table 9. Service satisfaction and degree of acceptance.

Scale dimension	Questions	Average score	Cronbach's α reliability coefficient
1. Information system service quality	11	4.73	0.94
1.1 Information quality	4	4.66	0.79
1.2 System quality	3	4.73	0.90
1.3 Service quality	4	4.83	0.90
2. User self-efficacy	3	4.16	0.82
3. User perceived risk	3	3.15	0.81

Figure 5 Shows usage of ComCare service functions at different times of the day, and it reveals total log records, health-related blog records, and social-related log records. It is evident that trends are similar for all types of services; service usage tends to peak during the period from 6 o'clock to 10 o'clock in the evening, and usage is also high from 10 o'clock in the morning to noon and from 3 to 6 o'clock in the afternoon. This pattern may be due to the fact that users are taking part in club activities or part-time work during the daytime.

The overall average score in the ComCare service perception survey, at 4.38, was relatively high. This value consists of three major dimensions:

(1) Information system service quality: Such as the ComCare system's ease of use, breadth of information provided by ComCare, and quality of unit services provided by ComCare.
(2) User self-efficacy: Such as user's ComCare operation self-confidence and ability.
(3) User-perceived risk: Personal information security, etc.

This study used Cronbach's α coefficient to test the questionnaire's reliability, ensuring the internal consistency of scales for different dimensions and confirming that the questions in each dimension measured the same properties. With regard to the average score for each dimension and reliability indicators (Cronbach's α coefficient) shown in Table 9, the composite reliabilities of all dimensions exceeded 0.79, indicating that the reliability of the questionnaire results was quite good. In particular, information system service quality reached the highest average score, 4.83, indicating that test users were very satisfied with ComCare's service. In addition, the average scores for system quality and information quality were also very high (4.73 and 4.66 respectively). The average score for users self-efficacy was 4.16; although most past research has suggested that seniors lack self-confidence when it comes to operating high-tech products [13], the study found that users' self-efficacy was above average. This result may have occurred because the socioeconomic situation in the Songshan District is relatively high compared with other districts of Taipei, and residents have a high degree of acceptance for new technology, which resulted in a fairly high self-efficacy for high-tech services and products. As far as perceived risk was concerned, the average score was 3.15; although the test users all had some Internet experience, they still retained some reservations and worries concerning the possibility of security problems such as disclosure of personal information. This is consistent with other research indicating that a steadily increasing percentage of seniors (over 50 years of age) is making use of the Internet, and that one of the obstacles facing Internet use by seniors is the issue of online security [14, 15].

Although users were quite satisfied with service on the whole, they still encountered some issues during the service implementation process. The following is an account of some of the problems encountered and how they were resolved:

(1) Because more than 90% of test users were using a touch-control tablet PC for the first time during the initial period of ComCare service, many were quite unfamiliar with tablet operating methods and procedures. In view of the circumstances, the project provided a customer service consulting hotline in order to help resolve user issues.
(2) Some users indicated that they found certain functions quite complex, such as uploading photos. Apart from providing the customer service consulting hotline, the project also designed a contest that encouraged users to share their photos and exchange knowledge to boost trial service performance.

In addition, user feedback and recommendations sometimes concerned product development integrity. Some examples of the most valuable feedback obtained during the service rollout process are outlined below; these responses provided important guidance for subsequent developments of service functions. First, following several explanatory meetings, it was discovered that elderly users hoped to have a simpler user interface. Addressing this need, the ComCare interface was redesigned to allow commands to be completed in only three steps whenever possible, and large fonts were employed to help seniors clearly read necessary information. Second, it was found that users placed emphasis on being able to access abundant and practical content. Because of this, apart from health management functions that allowed users to regularly record their health status, the team also designed functions meeting seniors' everyday social needs, such as a voice calendar, news information, and video. Third, because of physical and psychological changes affecting the elderly, it was deemed necessary to improve exercise, perception, and cognition products; the R&D team therefore developed a special series of physical sensation healthcare games that offered health benefits.

In summary, numerous innovative technologies, such as distant residential health applications, are being used to improve health management for seniors, and applications for seniors with chronic diseases are especially numerous [16]. Nevertheless, the ComCare home health service not only provides the elderly with health self-management capabilities, but also allows them to better achieve a satisfying mental and social life. We expect that the ComCare system will become an excellent overall solution providing residential seniors with a full range of mental and physical services.

4.2 *Future Classroom*

III's Digital Education Institute established a prototype Future Classroom in 2010 (Figure 6) in order to enhance classroom interaction, broaden learning and sharing, and employ the online resources concept to overcome the static instructional methods used in conventional teaching. We hope that the Future Classroom will bring the convenience of new technology into the classroom and create an even better technological teaching experience.

Figure 6. Future Classroom prototype.

Figure 7. Experimental classroom applications at Minsheng Junior High School.

Minsheng Junior High School adopted the Future Classroom concept in 2010, and it established a network-centered "connected classroom" for the school's major subjects that emphasized group learning, flexibility, and convenience. This classroom also serves as the study and promotion site for the fourth group of English instructors in the Songshan District, and the school has successfully developed modular English courses via technological instruction training and promotion of network-centered instructional plans.

This project provided further assistance in improving the instructional environment in 2011. Teachers can now use an electronic desk in conjunction with an electronic whiteboard and other peripherals, and there is a cloud teaching service platform and full WiFi deployment. The classroom can support use of tablet PCs for interaction between teacher and 36 students (see Figure 7). During 2011, the school jointly produced testing and assessment reports for three English teaching models in conjunction with Prof. Liao Yuan-kuang of the Department of Education at National Taiwan Normal University. The R&D results obtained in the Future Classroom have now allowed extension of new teaching methods to written Chinese, English, mathematics, nature, social studies, and general studies at Minsheng Junior High School. A total of 400 students are using the new methods in various classes, and their effectiveness has earned the praise of students and teachers alike. Table 10 summarizes extension progress in the experiment.

Table 10. Experimental extension status.

Year / Experiment item	2010 school year	2011 school year
Equipment	All-in-One PC	All-in-One PCs and Touchpads
Experimental subjects	English	Written Chinese, English, mathematics, natural sciences, social studies, general studies

Table 11. Analysis of learning effectiveness under three instructional models.

Instructional model	Group	Pretest		Post-test		T-test		ANCOVA	
		Average	Standard deviation	Average	Standard deviation	t	p	*F*	p
Grammar instruction	Experimental group (n=30)	14.47	5.39	19.13	3.61	-6.60	.000***	3.973	.05
	Control group (n=34)	13.59	6.01	17.12	5.39	-6.26	.000***		
Vocabulary instruction	Experimental group (n=28)	15.64	5.057	18.21	4.35	-3.69	.001**	.003	.960
	Control group (n=27)	16.07	5.697	18.22	4.53	-1.37	.183		
Reading instruction	Experimental group (n=33)	8.27	3.591	8.76	3.77	-1.21	.236	.495	.484
	Control group (n=32)	7.94	3.732	8.81	3.58	-3.14	.004*		

**p<.01 ***P<.005

Table 12. Key findings of user interviews.

Dimension	Topic	Content
Overall environment	Where any problems encountered in connection with overall classroom planning and hardware and software operation?	• There has been a reduction in equipment preparation time (T2) • There is no monitoring software, and class management must be performed verbally, making management difficult (T2) • The classroom layout caused the students to get in each other's way when answering questions (T1) • Students cannot make notes when using the tablet devices in classroom learning (T1)
Class preparation work	What differences have you encountered between the new and old systems in terms of class preparation and instructional model applications?	• Familiarization with platform operation is time-consuming in the short term, but the students gain familiarity with time (T1, T2) • Instructional design should be more detailed and varied, allowing students to participate vigorously (T1) • The new system involves a reusable teaching model—it is very time-consuming the first time, but will save time in the future (T2)
Teaching effectiveness	What influence have technological instruction activities had on student learning effectiveness?	• The use of technology in instruction can simultaneously boost the achievement of students on different levels (T1, T2) • Average students are interested and slower students don't give up (T1) • Simple concepts can help low-achievement students to catch up (T1, T2)
Future expectations	Do you hope to continue technological teaching in the future? Explain your answer.	• I hope there will be a table and chair for each person in the future (T1) • The teaching model can also be applied to other classes. As we become accustomed to technological instruction, we will gain experience through cumulative feedback and revision (T1, T2) • I would agree to continue to use the new method, with changes made to reflect the contents of different courses (T1, T2) • The platform allows the sharing of teaching plans. When many teachers are participating, we will be able to share more of the work, which may even save more time (T2)

The research project (Table 11) discovered that there were significant differences in the individual pre- and post-test pairwise comparison sample t-test results for the experimental group (technological instruction) and control group (ordinary instruction) (experimental group: t (29) = -6.60, p=.000; control group: t (33) = -6.26, p=.000). These results indicate that both innovative technological instruction and traditional instruction models were able to significantly improve the students' English grammar learning effectiveness. Nevertheless, analysis of covariance (ANCOVA) was employed to discover that the experimental group's post-test scores tended to be significantly higher than those of the control group (F (63) =3.973, p=.05), which indicates that the students receiving four weeks of technological instruction had better English grammar learning results than those receiving traditional instruction. Furthermore this study also discovered that low-achievement students in the experimental group enjoyed the most significant progress after receiving technological instruction, significantly reducing the gap between high- and low-achievement students. This suggested that teachers are better able to attend to the learning needs of low-achievement students in this type of environment, which will boost overall classroom learning effectiveness.

This study also interviewed classroom teachers concerning the teaching environment as a whole, their preparation workload, implementation effectiveness, and future expectations in order to gain a better understanding of teacher perceptions of technological instruction and obtain reference information to be used in the formulation of improvements in the future. Table 12 lists the chief interview findings. We discovered that while the use of technology in instruction can conserve teaching time, and can be applied to multiple courses, it imposes a relatively large burden on teachers in terms of class preparation and in-class management. Extension of the Future Classroom should possibly be accompanied by teacher training classes or increased extension workshops to boost teachers' familiarity with the technological systems.

4.3 *inMedia_Kiosk*

Taking one of the trial applications—"inMedia bus information station"—as an example, trial interactive services included bus information, nearby dining information, interactive picture-taking, "Taipei cultural creativity" information, and introductions to scenic spots. The principal bus information services included:

(1) Real-time information service

This service provides expected bus arrival times and displays the seven most recent buses arriving at the station in a flashing display in the upper right part of the screen. Users can employ instant messaging to have the expected arrival time (10 min., 5 min., 3 min.) of a specified bus sent to their cell phone. The billboard displays important real-time transportation information concerning the status of Taipei's transportation network.

(2) Transfer query service

This service provides information on buses traveling from the station to other nearby major transportation hubs, such as Metro stations, railway stations, and high-speed railway (HSR) stations, as well as major locations in Taipei (such as hospitals and universities).

(3) Route query service

This service provides information on all bus routes passing the current stop, and provides the locations of all buses on each route.

The design of the "inMedia bus information stations" was implemented in accordance with the service design and user-centered design (UCD) concepts. During this process, apart from comparing and studying existing related domestic and foreign products, the design team employed user research and joint design methods. Users participated in all stages of the design process: Starting with interviews with various types of bus users, the design team performed user text and image size perception tests and 1:1 paper fast modeling to gain an understanding of users' views and needs. With regard to the geometrical and functional layout of the display, the designers replaced explanatory text with a highly intuitive, self-explanatory graphic display, and employed centralized operating buttons to reduce users' learning burden and mental effort when querying bus routes, transfer routes, and waiting time. At the same time, the system also accommodates the physical needs and behavioral models of adults, children, middle-aged, and elderly persons. Finally, thanks to adjustment of product specifications and optimization of the user interface, the display posts clean visual aesthetics. The design of this service won the 2012 IF Communication Design Award (Figure 8).

Figure 8. Front page of the application—winner of the 2012 IF Communication Design Award.

4.4 *Green Life Ecological Tourguide*

This project was initially aimed at very young students. Although their level of smart phone use exceeded our expectations, the following problems and difficulties were encountered during the introduction of this service:

(1) Young students are readily influenced by their peers, are easily distracted, and are often unable to express themselves

This situation caused work personnel to encounter great difficulties when attempting to record test results. How to objectively record the participants' views was a key issue. Addressing these circumstances, we decided after discussions between work personnel and teachers to change the class' original static group experience approach to a dynamic group competition approach. In addition, group leaders were assigned to lead the group classes; effective learning occurred under the trainees' leadership. These changes significantly improved the learning experience, and the work personnel were able to successfully make records.

(2) Difficulty in confirming the value of the mobile guide service

Although this activity achieved a high level of user satisfaction, reduced the manpower needed in comparison with traditional guides, and the children participating in the class significantly improved their understanding of ecology (as revealed by question-and-answer sessions and quizzes given after the class), there was no control group to compare and confirm learning results. The design of the next stage of this project will therefore compare the results achieved by experimental and control groups, and a quantitative scale will be used to record and determine the actual value of the mobile guide service with regard to learning achievement.

Table 13. Summary of the most valuable feedback information ("Bug Reports").

Issues		Improvement method
Class design aspects	The route should reflect the need to provide shade and avoid sunstroke	This issue has already been improved. Apart from making contingency plans for especially hot or rainy days, arrangements have been made with the local borough office for providing emergency outdoor assistance
	Some of the plants observed were too similar to each other; the class will lack interest if only plants are observed	Distinctive stopping points of interest and guide content items have already been added. More local cultural points of interest and other features will be added in the future in conjunction with the district office, enriching the content of this App.
User interface aspects	The GPS positioning was inaccurate, and the distances between some plant points of interest rather short, which made judgments difficult	Although the problem of GPS errors cannot be resolved with current technology, this project has already put number markers next to notable plants, and has also installed large explanatory signs. This will help users determine plants' locations and find any points of interest that they may be interested in.
	The iPhone screen is tiny, and cannot be viewed by several people at the same time	Because this experiential ecological activity is aimed at groups of participants, but the iPhone screen is indeed not suitable for use by several people at the same time, an iPad version has been developed, and the App has been loaded for use in the activity. This problem will not arise during actual roll-out in the future, because many participants will consist of individuals using their own devices (such as their own cell phones).
Information content aspects	Because plant flowering and germination, etc. are quite seasonal, pictures in the App's built-in plant image library may diverge quite a bit from the plants' actual appearance, making identification difficult	The plant image library will be enlarged, and a plant points of interest browsing function with many images will be added to the App, helping participants identify specific plants.
	Can a plant name index be added?	More plant names have already been added to the App, and there are currently 59 plants. When a certain number of plants is reached in the future, an index will be added.

After two trials sessions, apart from achieving user satisfaction of 95%, the project also compiled the following valuable feedback ("Bug Reports") from on-site observation records, as shown in Table 13.

After selecting a route and designating a park, the system automatically locates and notifies the user about nearby ecological points of interest and will provide directions. Users can compare plant images with real plants and utilize the App's in-depth text guide service (Figures 9 and 10).

Figure 9. Screenshots of the mobile green living system

(a) (b)

Figure 10. (a) Parents and children were invited to test the summer camp experience tour and get a taste of mobile ecological education; (b) To facilitate recording of test results, the activity featured small group instruction. The group pictured here exhibited the best performance.

5. Conclusion and recommendation

5.1 Conclusion

Based on the empirical applications of the Living Lab, we have targeted three main groups: students and teachers, children, and the elderly. Table 14 below shows how these three target groups correspond to each of the four Living Lab frameworks.

The results of testing the Living Lab concept in the Minsheng Community reveal that key factors influencing the success of the testing process included determination of user needs, adjustment of use models, and use of adaptive designs. The ComCare service studied in this project enables users to conveniently maintain health management records in their own homes, and can enrich users' social activities. The health care games developed by the project team can provide seniors with new leisure activities, and also provide mental stimulation and hand-eye coordination practice. The results of this project's Future Classroom, which was designed to improve classroom instruction, displayed that, while both innovative, high-tech, and traditional instructional models can significantly boost the effectiveness of students' learning of English grammar, the high-tech model improved students' learning of English grammar more effectively than traditional instruction. This study also found that low-achievement students in the experimental group made considerable learning progress when receiving high-tech instruction, suggesting it can significantly boost learning effectiveness.

The use of real-time interactive designs enabled the determination of user needs and provided business opportunities for operating firms. This project's inMedia_Kiosk tests revealed that past efforts to use inMedia_Kiosk advertising did not conduct segmented marketing and mostly employed highly repetitious mass advertising videos. Image detection technology was used in this project to determine the characteristics of billboard viewers, and a real-time back-end platform determined appropriate advertising content for the current viewer segment. For instance, if a billboard determined that viewers consisted mostly of women, it would display advertisements of luxury goods; if it determined that viewers were mostly male, it would display advertisements of automobiles. This approach effectively prolonged the time viewers spent watching advertisements on the billboards.

Table 14. Feedback response from target groups regarding each of the four Living Lab frameworks.

Living Lab framework	Target Group for Future classroom		Target Group for Green Life Ecological Tourguide	Target Group for ComCare
	Teachers	**Students**	**Children (aged 6~12)**	**Elderly**
Perceiving	• Need to monitor students' learning progress • Lacks integrated multimedia and editing tools • Grading papers takes time	• Conventional teaching methods are less interesting • Questions are not answered immediately • Teaching materials are dry and difficult to understand	• Use smartphones to deliver ecological education activity guide • Solve the high costs and scheduling difficulties that are prevalent in conventional guidance tours • Upload ecological data to the cloud platform for more instant update	• There has yet to be a tool that helps the elderly manage their health conditions on their own • The elderly desire mental and spiritual satisfaction and support
Prototyping	IGCS design, practice activities, overall assessment and other cloud-based teaching services	Practice activities, overall assessment and other cloud-based teaching services	• Raise children's awareness to the green environment through education • Broaden the teaching scope through course designs and experience	• The 1st year (2010) mostly involved operating environment analysis and proof-of-concept. This was when the needs of the elderly were understood to design a humane, intelligent healthcare service. 20 trial users were selected for the ComCare device • The 2nd year (2011) was when proof-of-service took place. We began deploying service terminals at the experimental site, and to-date there are 325 devices located throughout the Songshan District. New services are under development
Validating	Cloud teaching service platform combined with mobile devices to enable innovative course preparation and instruction	Real-time interactions and teaching supplements	• Designate Minquan Park, Xinzhong Park, and Fumin Ecological Park as experimental sites. These 3 sites form a 1-hour long tour path that is suitable to most participants in terms of time and stamina • Encourage parental enrollment to children's summer camp. Two sessions were organized, recruiting 64 members in total (accompanied by 6 parents)	• Designate Minquan Park, Xinzhong Park, and Fumin Ecological Park as experimental sites. These 3 sites form a 1-hour long tour path that is suitable to most participants in terms of time and stamina • Encourage parental enrollment to children's summer camp. Two sessions were organized, recruiting 64 members in total (accompanied by 6 parents)
Refining	Integrates multimedia into teaching, allowing real-time interactions and teaching supplements	Arouses learning interest and improves effectiveness, especially the low-achievement students	• Incorporating fun and competitive elements to enhance children's focus for better effectiveness • Live quizzes and games • Multiple observers were present throughout the event. Everyone's observations were gathered, documented, and discussed at the end of the activity	• Designate Minquan Park, Xinzhong Park, and Fumin Ecological Park as experimental sites. These 3 sites form a 1-hour long tour path that is suitable to most participants in terms of time and stamina • Encourage parental enrollment to children's summer camp. Two sessions were organized, recruiting 64 members in total (accompanied by 6 parents)

5.2 Management Implications and Practice

The design of any new service must, during its initial stages, first take into consideration what changes or benefits it will provide users. The empirical results of several test cases in this project revealed that technological innovation must be geared to satisfying users' need for effective service and overall benefits. For instance, in the future, this project's ComCare home health service for seniors will be able to directly link physiological monitoring instruments, such as sphygmomanometers and glucometers, directly with ComCare, providing users with a comprehensive health management system. In addition, this project will continue to extend ComCare service functions to the fields of residential management and safety monitoring so as to fully meet the information service needs of an aging society. With regard to the Future classroom, future development efforts will emphasize usability and overall system stability. More technological instruction models suitable for the classroom environment will be developed, and it is expected that these models will soon be used for practical instruction in schools at all levels. The project found that inMedia_Kiosks must take advantage of the multiplier effect brought by various services to give viewers a novel impression, while ensuring that consumers obtain the information they want from the billboards. As a result, it will be essential to gain a better understanding of consumers' information needs and further develop the key areas of detection technology, interactive technology, and back-end value-adding platform technology in order to develop more effective inMedia_Kiosks.

The Living Lab concept requires selection of appropriate sites or locations before localized development can proceed. In order to provide a solid foundation for the experiments, promotional measures must be developed with long-term, grassroots perspectives in mind. As such, maintaining good collaborative relationships with local organizations and businesses is key to achieving success when testing new services. While technological R&D is relatively unaffected by geographical restrictions, finding areas with good cooperation and clear-cut target groups is also important for the success of service tests.

Apart from creating an innovative Living Lab demonstration community, the implementation of this project and other Living Lab projects in the Minsheng Community will provide an excellent reference experience for developing living labs in other locations. It should be emphasized that the continued implementation of test projects, expansion of the test scope, and improvement of effectiveness all depend on establishing and maintaining sound cooperation mechanisms with the city government, district offices, borough chief’s offices, schools, associations, and local leaders, as well as enlisting their support and participation.

There are currently no organized living lab programs in Taiwan, thus the test cases in this project were conducted autonomously. Apart from steadily perfecting living lab methodologies, it will also be important to gradually establish a reliable, regular test team that includes test subjects in various fields, and mechanisms should be drafted to invite subjects to participate. After these resources have been established and enriched, we will be able to assist with living lab testing of any domestic R&D projects in the future. By developing a win-win innovative operating model that benefits both businesses and consumers, and engaging in international interchanges, we have confirmed Taiwan's role as a promoter of the Living Lab movement.

References

[1] *Living lab taiwan*, Institute for Information Industry, [Online]. Available: http://www.livinglabs.com.tw/index.html [Accessed: Dec. 25, 2011]

[2] *Population and number of households in Songshan district*, Household Registration Offices, Songshan District, Taipei City, 2009, [Online]. Available: http://www.ssdo.taipei.gov.tw/ct.asp?xItem=8805&CtNode=2003&mp=102041 [Accessed: Dec. 21, 2011]

[3] "2008 Songshan healthy city project report," Healthy City, Taipei, 2008. Available: http://www.songshan-healthycity-taipei.org.tw/Doc/ReportTW/Page1-22.pdf.

[4] *Songshan healthy city profile*, Healthy City, Taipei, 2008, [Online]. Available: http://www.songshan-healthycity-taipei.org.tw/City%20Profile.asp?eng=0&obj=submenu1# [Accessed: Dec. 23, 2011]

[5] E. C. Schmid, "Developing competencies for using the interactive whiteboard to implement communicative language teaching in the English as a foreign language classroom," *Technology, Pedagogy and Education,* vol. 19, no. 2, pp. 159-172, 2010. doi: 10.1080/1475939X.2010.491218

[6] P. Mishra and M. J. Koehler, "Technological pedagogical content knowledge: A framework for teacher knowledge," *Teachers College Record,* vol. 108, no. 6, pp. 1017-1054, 2006.
Available: http://www.tcrecord.org/Content.asp?ContentID=12516

[7] J. P. Holdren and P. R. Ehrlich, "Human population and the global environment: Population growth, rising per capita material consumption, and disruptive technologies have made civilization a global ecological force," *American Scientist,* vol. 62, no. 3, pp. 282-292, 1974.
Available: http://www.jstor.org/stable/27844882

[8] *Partnership for 21st century skills (p21)*, Partnership for 21st Century Skills (P21), [Online]. Available: http://www.p21.org/ [Accessed: Dec. 21, 2011]

[9] Y. Tsai and K. J. Tsang, "Self images and social roles: A study based on the aging people and their contacts with the internet," *Mass Communication Research,* no. 97, pp. 1-43, 2008.
Available: http://mcr.nccu.edu.tw/

[10] L. Gamberini, M. Alcaniz, G. Barresi, M. Fabregat, L. Prontu, and B. Seraglia, "Playing for a real bonus: Videogames to empower elderly people," *Journal of Cyber Therapy & Rehabilitation,* vol. 1, no. 1, pp. 37-48, 2008.
Available: http://journalofcybertherapy.webs.com/volume1issue12008.htm

[11] D. Mellor, L. Firth, and K. Moore, "Can the internet improve the well-being of the elderly?," *Ageing International,* vol. 32, no. 1, pp. 25-42, 2008.
doi: 10.1007/s12126-008-9006-3

[12] C. Neufeldt, "Wii play with elderly people," *International Institute for Socio-Informatics,* vol. 6, no. 3, pp. 50-59, 2009.
Available: http://www.iisi.de/fileadmin/IISI/upload/IRSI/IRSIV6I3.pdf

[13] T. Reisenwitz, R. Iyer, D. B. Kuhlmeier, and J. K. Eastman, "The elderly's internet usage: An updated look," *Journal of Consumer Marketing,* vol. 24, no. 7, pp. 406-418, 2007.
doi: 10.1108/07363760710834825

[14] W. Maaß, "The elderly and the internet: How senior citizens deal with online privacy," in *Privacy online*, S. Trepte and L. Reinecke, Eds.: Springer Berlin Heidelberg, 2011, pp. 235-249.
doi: 10.1007/978-3-642-21521-6_17

[15] J. F. Coughlin, J. E. Pope, and B. R. Leedle, "Old age, new technology, and future innovations in disease management and home health care," *Home Health Care Management & Practice,* vol. 18, no. 3, pp. 196-207, 2006.
doi: 10.1177/1084822305281955

[16] T. Botsis and G. Hartvigsen, "Current status and future perspectives in telecare for elderly people suffering from chronic diseases," *Journal of Telemedicine and Telecare,* vol. 14, no. 4, pp. 195-203, 2008.
doi: 10.1258/jtt.2008.070905