Article

Participatory Design to Enhance ICT Learning and Community Attachment: A Case Study in Rural Taiwan

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Abstract: This study used observation and interviews with participants in "PunCar Action" to understand how participatory design methods can be applied to the education of rural individuals in information and communication technology (ICT). PunCar Action is a volunteer program in which ICT educators tour the rural communities of Taiwan, offering courses on the use of digital technology. This paper makes three contributions: First, we found that participatory design is an excellent way to teach ICT and Web 2.0 skills, co-create community blogs, and sustain intrinsic motivation to use Web applications. Second, PunCar Action provides an innovative bottom-up intergenerational ICT education model with high penetrability capable of enhancing the confidence of rural residents in the use of ICT. Third, the content of basic courses was based on applications capable of making the lives of elderly individuals more convenient, and the advanced course was based on the co-creation of community blogs aimed at reviving the core functions of communities and expanding local industry. Our research was conducted with the use of a non-quantitative index to measure ICT learning performance of participants from a rural community. The results show that PunCar Action emphasizes interpersonal communication and informational applications and creates a collaborative process that encourages rural residents to take action to close the digital divide.

Keywords: collaborative learning; computer-mediated communication; digital divide; digital inequality; participatory design; rural studies; social class

1. Introduction

In 2010, over 90% of all households in Taiwan owned a computer and 82.8% of these had internet access [1]. In a survey of 181 countries in 2007, Taiwan ranked seventh in the Digital Opportunity Index [2]. However, even today the digital divide remains an issue in remote areas of Taiwan. Government policies often fail to eliminate barriers to the usage of emerging technologies in remote areas. The government has invested in information hardware, popularized broadband access, and provided instruction for basic internet skills; however, little effort has been made to enhance practical applications [3].

Following the examples of South Korea and Chile, information and communication technology (ICT) is being used in Taiwan as a means to decrease social inequality [4]. In Canada, ICT fosters social capital and improves processes of life-long learning [5]. Stern and Adams [6] found that Internet usage can enhance volunteerism and community attachment in rural communities. In America, social networking sites are being used to foster the community involvement of rural youth [7].

This study sought to determine the means to enhance the capabilities of Web applications for residents of rural communities through ICT education. Our focus was on the elders and residents of lower social status with a secondary aim of evaluating the effects of these measures on community attachment. This study analyzed the application of "PunCar Action", according to the requirements of remote communities with regard to e-accessibility and digital development. In 2010, PunCar Action provided a diversity of web courses on life applications as well as intergenerational learning.

1.1. The Digital Divide in Taiwan

Despite considerable success in the field of information technology, Taiwan still faces a digital divide. In the dissemination of ICT, it is inevitable that the timing associated with the introduction of new technologies will influence the proficiency with which users practice ICT [8]. This issue is most noticeable as it pertains to age, geographical location, ICT education, and social status [8–10]. Studies have demonstrated that the uneven distribution of information resources can be attributed to the distance between urban and rural areas [11,12]. For example, computer ownership and internet usage rates are far higher in northern Taiwan (which is more metropolitan) than in other regions. Internet access rates also vary according to the degree of urbanization. Among individuals 51–64 years of age, residents of Taipei City present the highest internet usage (68 per cent), while residents of Changhua County, Yunlin County, Chiayi County, Tainan County/City, Kaohsiung County and Pingtung County (the rural areas of Taiwan) have the lowest internet usage (18 per cent) [13]. Aside from age and urban–rural issues; In 2010, immigrant brides accounted for 1.95% of the total population of Taiwan; however, in remote areas, as many as 34% of the students in elementary schools have immigrant mothers [14]. Thus, immigrant brides have become a new focus of ICT courses aimed at bridging the digital divide.

To address the rural–urban digital divide, the government of Taiwan introduced a "Create Digital Opportunity for Rural Areas" project which ran between 2005 and 2011. The official "National Information and Communications Initiative Committee", educational institutions, and local governments cooperated to establish "Digital Opportunity Centers" in 300 rural communities. These centers offered a number of courses, including information literacy, computer-based training, web design, computer

maintenance, computer programming, e-commerce, and website backend management [15]. These courses emphasized the uniformity of the content, and quantitative indicators, such as the number of participants or internet hardware and equipment [3]. These courses were not designed to appeal to different students and the ICT skills were not based on rural community development.

The core issues in bridging the digital divide between urban and rural areas in Taiwan are as follows: (1) Identifying the requirements of rural residents with regard to the development of ICT skills; (2) Determining the means of using digital applications to make rural life more convenient and further the development of communities; and (3) Establishing suitable methods for the instruction of elderly individuals in rural areas.

1.2. Background of PunCar Action

"PunCar Action!" is the first digital divide project in Asia that maintains records in real-time and utilizes Web 2.0 technology services. The project was implemented by a non-profit organization, the Association of Digital Culture, Taiwan (ADCT), and targets rural communities and social welfare organizations. The first ICT education course was offered in May 2008 [16]. The founders of PunCar Action, Hsu Ting-Yao and Hsu Tzu-Han, are famous bloggers who grew up in the metropolitan area of Taipei. They have a deep knowledge of digital technology as well as tremendous ICT skills and a passion to share their knowledge. Two concepts drive the program, which the creators describe as follows: "let Otaku (a Japanese term used to refer to young people with obsessive interests, particularly anime, manga, or video games) teach residents of rural communities in the use of computers and the internet," and "move the computer classroom to the front door of your home". They borrowed money to buy a van (in Chinese, van is literally translated as bread car, and Pun is the Taiwanese word for bread, hence, the name PunCar), and installed information equipment inside. The PunCar carried volunteer lecturers on a tour around Taiwan for the provision of digital education (see Table 1). They sought to disseminate knowledge about information technology, explain the current status of applications, and help to digitalize and promote the features of rural communities.

Table 1. PunCar Action tour record (up to the end of 2012).

Implementation unit	ADCT, Association of digital culture Taiwan (NPO)
Starting date	May 17, 2008
Total lectures	628
Total teaching hours	2884 h
Average number of students per lecture	15
Number of volunteer lecturers	88
Average number of lectures at each community	6.5
Total number of students	12,056
Average age of students	53.2 years old
PunCar Action Van	Replaced four vans
Total mileage	316,000 Km

PunCar Action directly addressed the digital divide by sending people and resources to remote areas. Volunteers developed flexible participatory courses in order to disseminate knowledge about internet tools and also combined life applications with community features. PunCar Action focused on the quality of offered courses while the government focused on quantity. PunCar Action represents a groundbreaking idea for the youth of Taiwan, and provides a new approach to achieving e-inclusion in rural communities. The project won the "digital community" award at the 2010 ARS Electronica in Linz, Austria [17].

2. Methods

The authors visited communities to determine technology requirements, observed classes, and employed in-depth interviews with volunteers and participants.

The survey was conducted between January and December 2010. PunCar Action spent 75% of the time in Tainan County, including 36 communities and 138 courses. Data collection approach through Association of Digital Culture, Taiwan (ADCT) and author's previous pilot study [18] of PunCar Action.

The case study was conducted in Tianpu community, Yujing District, Tainan County, Taiwan. This area is representative of a typical farming rural community in Taiwan. It suffers from an out-migration of youth, has a high percentage of elderly citizens, and a high percentage of immigrant brides. Thus, community leaders demonstrated a strong desire to enhance community attachment through digital tools. Residents of Tianpu community also participated in government run Digital Opportunity Centers in 2008 and began taking PunCar courses in 2009. This made it possible to compare the two approaches to teaching with a common aim of overcoming the digital divide.

Interviews were conducted with four PunCar students (three elderly and one immigrant bride) and two community cadres who participated in at least 10 classes as well as the PunCar execution team (Table 2).

Table 2. List of interviewees.

Group	Interviewees	Content	Notation
PunCar students	Mr. SA	Their opinions about computers and the internet before taking the courses/the greatest reward obtained from the courses/their favorite content/ their follow-up ideas on how to use the Internet	Age 68, farmer
	Ms. SB		Age 60, housewife
	Mr. SC		Age 70, retired farmer
	Ms. SD		Age 29, immigrant bride
PunCar executives	Cheng-Li Hsu	Their observations and thoughts of digital divide in rural communities/how to communicate with communities to learn their requirements/teaching experiences/programming experience of teaching materials and methods	Age 32, PunCar lecturer
	Che-Ming Wu		Age 28, the director of PunCar
	Ting-Yao Hsu		Age 33, the founder of PunCar
Community members	Ms. CA	Their expectations towards the PunCar curriculum/their opinions on the ICT curriculum in terms of community development combined with operational experience	Church pastor
	Mr. CB		Community Leader

2.1. Participatory Design Methods in ICT Learning

This study records the teaching and learning process using the form of Participatory Action Research (PAR) [19]. Researchers participated in the teaching process, observed other instructors, and conducted in-depth interviews with members of the community, students, and the execution team of PunCar Action. The aim was to discover how rural communities deal with the digital age and social-economic status; for example, we attempted to determine which ICT applications are required by residents, how ICT tools could assist in solving problems communities face, and how residents could co-create community blogs to achieve collaborative intelligence, to help in the revival of their communities. Aside from typical top-down digital divide teaching policies, the scope of this study was to provide an alternative digital mobile education program based on qualitative appeal. ICT applications in rural communities could connect people and information, while addressing the needs of the community.

Participatory design in educational research allows learners of all ages to become co-designers of courses. Most participatory design research employs interviews and participant observations to reveal user opinions on the use of technology in daily life. Seale [20] asserted that the strong narrative and deep insights of these methods could be of relevance "to research that focuses on hearing the 'student voice' in relation to successful digital-learning experiences".

Participatory design involves the design and development of systematic techniques to encourage the active participation of users in the decision-making process. Sanoff [21] indicated that participatory design is an attitude regarding the power to establish change and manage the environment in which we live. Participatory action research (PAR) has been widely applied in fields such as public health, resource management, adult education, and rural community development. The common idea of all PAR methods is that users should participate in the technical design process that affects their lives and work [22]. Favorable outcomes usually result when designs stimulate the tacit knowledge of users as well as their collective intelligence [21].

Other participatory design methods, such as scenario-based design and design games, allow students to participate in the process of co-creation and brainstorming aimed consensus building through intergenerational activities and scenario-based simulation [23]. In recent studies, the participatory design method has been widely used to facilitate the cooperative exploration of children [24] and the collaborative construction of a Web 2.0 online learning environment for college students [25]. These studies demonstrate the effectiveness of this method in identifying the educational requirements of learners. However, few studies have used participatory design in ICT teaching the elderly in remote areas, particularly individuals with little experience in the use of digital tools. This study veered away from quantitative assessment methods in favor of a qualitative approach to exploring the motivation behind learning.

In accordance with a collaborative research framework involving participatory design, this study analyzed the ICT curriculum and operational process conducted both by PunCar Action and rural communities. A further goal was to explore the influence of Web 2.0 digital communication on bridging the digital divide in rural communities and encouraging community attachment.

2.2. Research Framework

PunCar Action's ICT teaching program adopted in-depth counseling and participatory design for the planning of curriculum in accordance with the age, socio-economic status, and acceptance of digital tools by participants as well as the features of the communities. Thus, residents were able to master the digital curriculum themselves, and learn how to apply the ICT tools they really needed. The stakeholders in PunCar Action include: NGO-PunCar executives (lecturers, volunteers, and administrative staff), community members, PunCar students, and social workers in local government. Through a division of labor and collaboration on the participatory design (Table 3).

Table 3. PunCar Action partnerships and activities with stakeholders.

| Stakeholders	Focus on collaborative activities
PunCar executives	Communicating with communities and learning their actual ICT application requirements; analyzing tour experience
PunCar lecturers	Planning and designing the curriculum; giving lectures; adjusting the teaching material and method
PunCar volunteers	Helping students to operate the ICT tools one on one; setting up class equipment
Community members	Offering an introduction to community features; outlining the goal of promoting a digitalized community
PunCar students (ICT curriculum)	Voicing their ICT application requirements and learning the skills; Co-creating community blogs
Social workers in local government	Injecting resources from the local government, such as hardware and community development funds
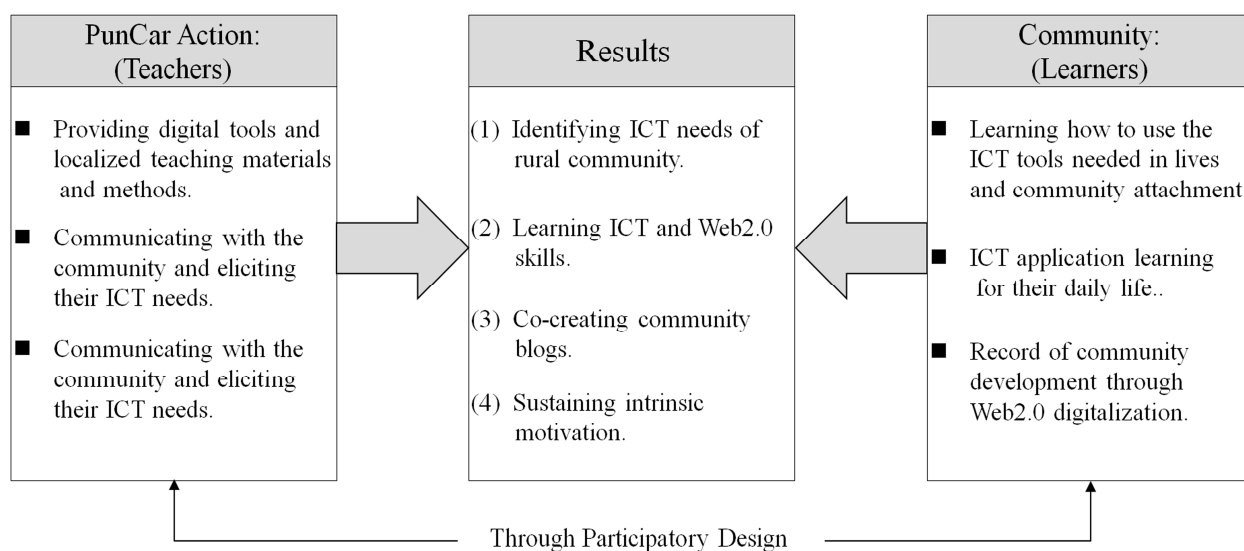
Figure 1. Through participatory design, teachers and learners were able to collaboratively plan the Information Communication Technology (ICT) curriculum and lecture mode most suitable for the community.

Using the research framework of participatory design in the field of learning applications our detailed research specifically focused on the topic of ICT learning. The study covers four main topics (shown in

the central part of Figure 1 and will be clarified detail result in the following Section 3.1 to Section 3.4): identifying the ICT needs of students in the rural community, learning how to operate ICT and Web 2.0 tools, co-creating community blog, and sustaining students' intrinsic motivation for follow-up learning and exploring further applications. On the left side of the figure, "teachers" are defined as the stakeholders in the PunCar organization; while "learners" are defined as community members and students. Both groups collaboratively participate in the process to co-create an ICT curriculum suitable for the community as well as an ICT application that is capable of achieving the digitalization of the community.

3. Case Study Results

3.1. Identifying ICT Needs of Rural Community

Community representative Ms. CA: "In the past, education and information agencies also taught senior citizens how to use the computer, but perhaps the materials were too hard, the courses moved too fast, or they were just plain boring, so elders were often unable to understand and apply what was taught. This made them even more afraid of computers and the internet".

The most important parts of the service process of PunCar Action (Figure 2) include the two to three visits to the registering community to understand the requirements and arrange courses after the requirements have been evaluated, including the selection of suitable lecturers. During the tours of ICT teaching activities, each lecture was recorded on a blog, and after class, lecturers and volunteers provided either face to face or online assistance to students, and adjusted the content of the next class if necessary. For example, the course on how to use voice and video over IP communication tools, although originally designed using Skype, could be adjusted to teach the installation and operation of Google$^+$ Hangouts if the students' grandchildren were more accustomed to this tool.
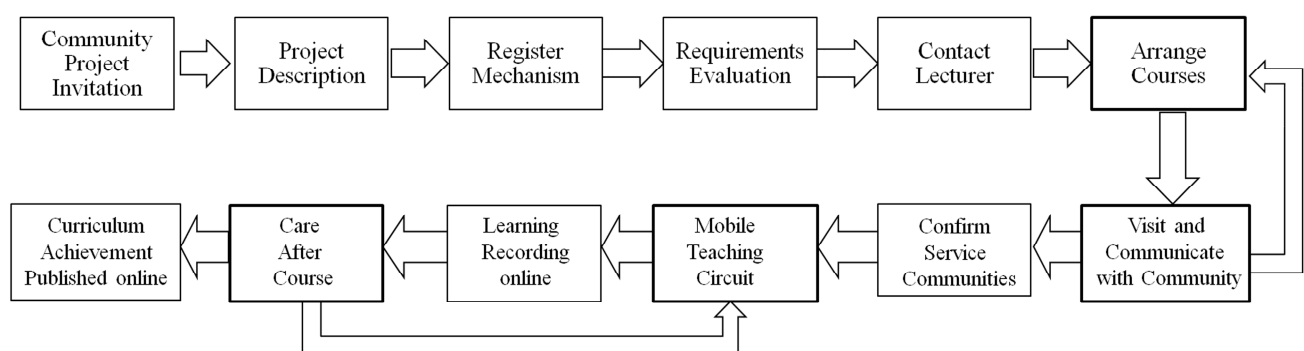

Figure 2. ICT teaching process of PunCar Action.

Director Che-Ming Wu of the PunCar south Taiwan center: "After driving PunCar on a tour of over two hundred courses, I found that 'communication' was an intangible but immense cost. Yet, it was the only way to provide quality courses. If the framework of digital divide does not demand or allow for communication, then pursuing 'what to learn' and 'how to learn' in ICT learning will be deemed unnecessary." "...We had many discussions with community members and students to identify the community's real ICT needs. That is the major difference between PunCar Action and the more common top-down and unitary digital curriculum."

3.2. Learning ICT and Web 2.0 Skills

Ting-Yao Hsu, founder of PunCar Action: "For a long time rural communities relied not on digitization, but rather on passion and connections between people. Is digitization necessary for them? What benefit can ICT learning provide to them?"

PunCar student Mr. SA: "I previously took the computer course for elders offered by the community. At that time, they immediately taught us how to use e-mail, but I had nobody to write to. So going to class was like pursuing fashion, but it wasn't long before I had forgotten everything they taught about computers and the internet."

PunCar courses are divided into basic courses and advanced courses (as shown in Figure 3). Basic courses consist of two to three classes, with the primary aim of guiding residents to come into contact with computers, so they are not afraid and develop an interest in learning ICT. The majority of course content focuses on life applications via the internet, including going online to browse the news, read weather reports, make a hospital appointment, buy train tickets, and use Skype. Advanced courses are adjusted according to each community's requirements in terms of the number of classes and the content; there are generally four to seven classes. Students focused on learning advanced skills in internet applications, such as uploading pictures and videos, writing a blog, and using social networking sites. These skills were then connected in the creation and maintenance of a blog on broadcasting the features of the community.
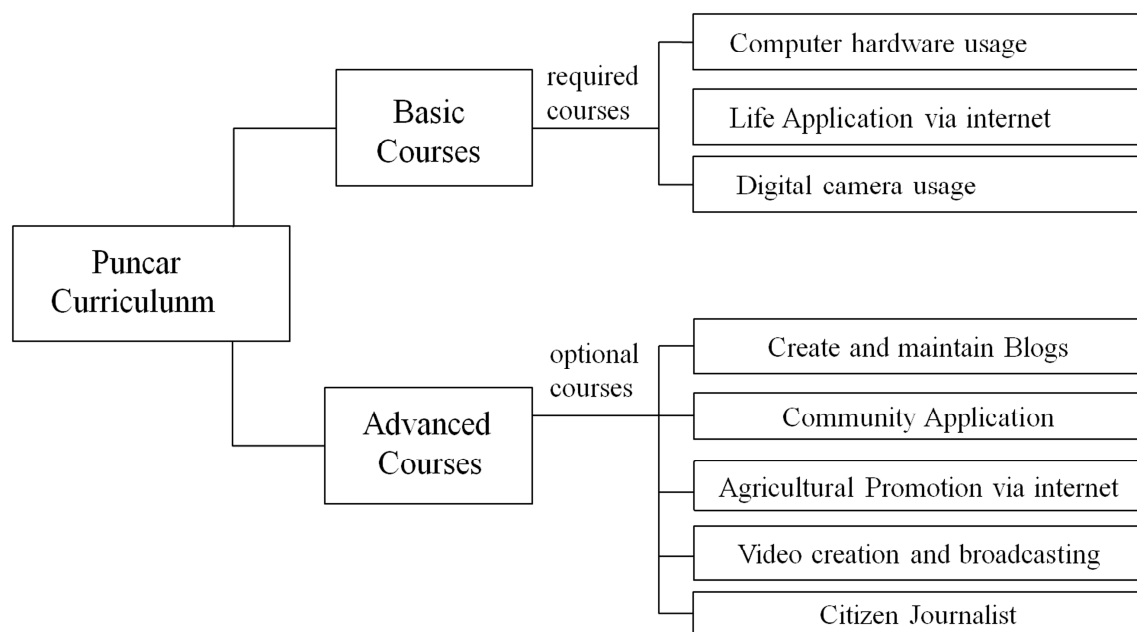

Figure 3. PunCar Curriculum.

PunCar's ICT courses use many freeware applications as its teaching platforms, such as Google map, Blogger, Picasa, and YouTube to allow residents of rural communities to come into contact with digital information via the cheapest, most easily acquired ICT tools.

PunCar student Ms. SD: "PunCar teachers taught me how to make phone calls using Skype. It is much cheaper to make phone calls using internet phones. In class I learned how to search for Ho Chi Minh City using Google map, and was very glad to see my hometown."

Community representative Mr. CB: "Our community is very beautiful and has many features. Through PunCar's blog class, community residents can go online to edit and record everything that goes on in their community; it has drawn everyone even closer together."

Because the majority of students are elders and immigrant brides, who would like to learn about digital technology but are afraid. Thus, the ICT teaching method of PunCar Action for rural communities aims to reduce their fear of operating computers involves slow and patient communication during interactive teaching, and step by step guidance in the operation of computer hardware. This helps the students to feel more at ease with ICT tools.

Teaching features of PunCar Action include the use of local dialects (southern Taiwanese dialect) and easy to understand terms instead of technical terms (e.g., using "open the box" instead of "open the window"). Another feature is the interactive teaching method; for example, the lecturer and volunteers guide the hands of elderly students to click the mouse, so that students become familiar with the feel and the cursor's corresponding movement.

PunCar Student Mr. SA: "Classes taught by young PunCar teachers are very interesting, and easier to understand because they are taught in Taiwanese instead of Chinese. Retired senior citizens in the community gather together to learn how to use the internet; we ask the teacher whenever there is something we do not understand; there is no need to feel embarrassed. Now, I can post photos onto the blog; it is very interesting…"

3.3. Co-Creating Community Blogs

The open and highly interactive features of Web 2.0 complement the concepts of participatory design; therefore, PunCar Action chose blog platforms for the core curriculum. According to the requirements of the communities, we divided the content of the blog and the corresponding ICT training courses into two main categories (Table 4). When the community blog had an explicit position and framework, students participated in co-creating new digital content to maintain the blog.

Table 4. Two categories of functional attributes of community blogs.

Reviving the core functions of communities
Through its interaction with the communities and understanding of local customs and practices, PunCar Action engaged in communication with those residents who had a positive learning attitude, and helped them to build and use the community blogs as the core of the curriculum. In addition, student learning conditions were evaluated. If the conditions were desirable, they would arrange more courses such as using internet communication tools, camera techniques, simple photo editing and management, and online digital map applications. Internet tools link all the service points together, which help to revive current community services and functions.
Local characteristic industry marketing
Although the core curriculum was also designed to teach residents how to build and use community blogs, PunCar Action helped communities with local characteristics and local industries to enhance their ability to develop more integrated internet applications. The main courses included camera techniques, simple photo editing and management, online digital map applications, audio-visual media applications and internet marketing practices. For each community, it benefitted network management and operations.

Tianpu community in Yujing District is a successful case of a local characteristic industry. One of its distinctive products is the "loofah scrub sponge", which has an excellent online reputation. The PunCar execution team helped the residents to change the original version of the community blog, and brought in more internet tools and tips for internet marketing [26].

Asking "What should ICT tools be used for?" is more critical than "learning how to use these tools." This is the reason why PunCar Action chose the co-creation of a community blog as the focus of teaching in ICT advanced curriculum. Internet and digital technology could help to promote the local features of rural communities. The diverse content and collection are both created by the collaborative application of the ICT skills of residents.

3.4. Sustaining Intrinsic Motivation

Community representative Mr. CB: "When the community blog was established, PunCar students began using digital tools and recording everything in the community by text or video. Even those residents who studied or worked in other places came to the blog and left messages..."

PunCar students MS. SB: "Recently, some retired friends got together and played around with recording and film editing. We posted the records of community tree planting activities online, and got many responses, which really encouraged us. We want to post more interesting things on the internet so more people would know more about our community Tianpu..."

Director Che-Ming Wu of the PunCar south Taiwan center: "Through PunCar's ICT teaching tour, we found that knowing 'how these digital information tools are used to solve the problems the communities face' is more important than just knowing 'how to operate these tools'. At present, PunCar helps many rural communities find their own local perspectives and lets the cold digital tools find useful applications in these communities..."

PunCar lecturer Cheng-Li Hsu: "Teaching the use and application of digital information tools is just like spreading seeds. Learning how to operate these tools raises the students' enthusiasm; then, by promoting themselves on social network sites, unknown communities can be connected through the Internet to a large audience and become better known..."

The teaching of the PunCar ICT curriculum in rural communities focuses on the appropriate application of digital information. There are 7–8 courses in a single curriculum; therefore, the digital ability that residents acquire is actually quite limited. Thus, the key point is to achieve community cohesion through the joint participation of both community students and the PunCar execution team. In the advanced curriculum of community blog co-creation, PunCar also introduced social network media, including Facebook, Plurk, and citizen journalism platforms. Students who have taken PunCar courses demonstrated continued enthusiasm for promoting their communities, and applied their ICT skills to share their lives and the features of their community on these social network sites; for example, Shanhua Community News, Tainan on PeoPo citizen online news platform [27] and "Tianpu Community" fans page on Facebook [28].

Through the dissemination of messages on social network sites, these rural communities have attracted considerable attention from their neighborhood and even from other cities throughout the country. This has contributed to actual visits of the communities and in-depth exchange.

4. Discussion

This study focused on the elderly and immigrant brides learning ICT skills in rural communities. In this chapter, we examine the characteristics of PunCar Action, the effect of participatory design on ICT learning in rural communities, and ICT courses that are suitable for rural residents and applicable to the revival of communities.

4.1. Analysis of PunCar Action's Features

The core concept of PunCar Action is to reduce digital divide in remote areas. Young adults or volunteers from metropolitan areas sent information, equipment, and resources to remote areas and used systematic mobile ICT education models with high penetrability. They carried out the teaching tours based on the needs of different communities, and presented lectures in a way that the elderly and immigrant brides could understand. Compared to standard teaching methods and similar courses commonly used in Taiwan [3] with quantitative evaluation the performance of digital divide (refer to Figure 4 left), this is the most significant feature of PunCar Action's urban–rural digital divide reduction program Figure 4).
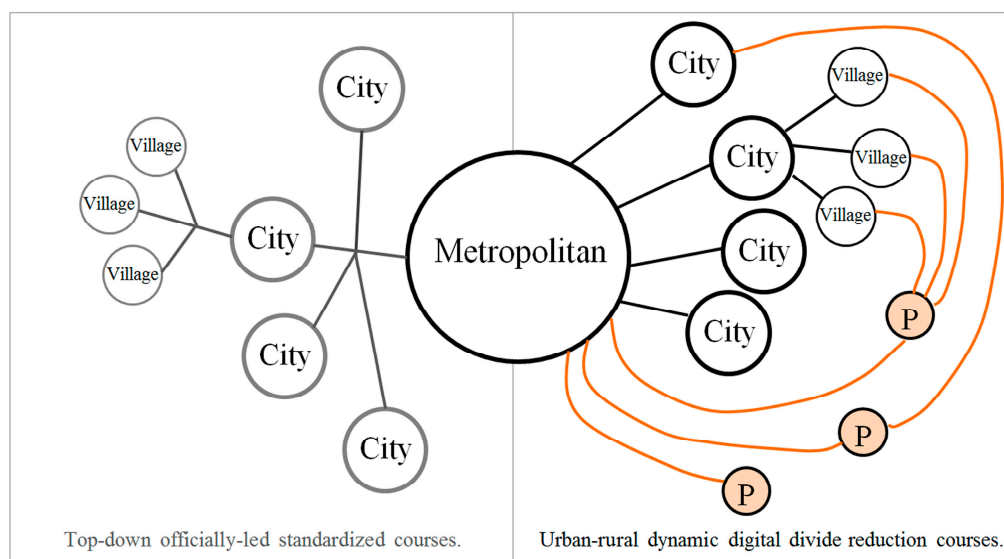

Figure 4. Comparison of a top-down standardized course (left site) and PunCar Action's approach to bridging the digital divide (right site). P stands for PunCar Action.

With respect to the ICT teaching tours to rural communities, this study also summarizes three features of PunCar Action through participant observation:

(1) **Bringing "economical" equipment into courses:** The internet environment is set up using computer equipment from community centers, churches or temples, together with laptops, digital cameras and network equipment provided by PunCar. Freeware applications (Google map, Blogger, Picasa, YouTube) are used as the main teaching platform.

(2) **"Friendly" teaching of ICT tools applications:** In a technological society, a sense of uncertainty among most senior citizens means that they forgo opportunities to engage in ideas and activities in which the younger generation participates [29]. Intergenerational education is adopted to

eliminate digital divide between urban and rural areas, adjusting the roles of "teachers" and "students". The primary goal is to remove senior citizen's fear of computers and the internet. Thus, courses are taught in local dialects, students gain experience using computers, instructions are given at a slower pace, and the themes are related to the community. This friendly teaching environment allows rural residents to gain a sense of familiarity and achievement through the use of ICT tools (both hardware and software).

(3) **Tour courses in nearby areas:** To determine whether intergenerational learning is successful, what should be noted is not only whether the activities are designed to meet the objectives of the program, but also the participants' interests and abilities, as well as the assessment of actual conditions [30]. In this case study, whether the classroom is near enough to their home is crucial to a senior citizens' enthusiasm for learning. Daily activities of residents in rural communities are mainly at community centers, and PunCar students form a learning group with a degree of homogeneity (*i.e.*, age, lifestyle patterns, interests). For these reasons, the mobile classroom of PunCar selects places near the homes of participants for the convenience of community residents. This reduces their fear of ICT by creating a relaxed environment, and increases the community learning groups' passion for learning how to use ICT.

Although PunCar Action initially aimed to "reduce digital divide", this study discovered that the digital mobile classroom of PunCar Action, which visited rural communities in 2010, had already conformed to principles established by "e-Inclusion" [31]. The project implemented information education by "establishing a society without information barriers, so that people with different levels of education, gender, age and those living in different areas will enjoy the same opportunity to come into contact with and use information, creating a society without discrimination."

4.2. How Participatory Design Affects ICT Learning in Rural Communities

(1) **Teaching and learning in participatory design:** Participatory design emphasizes both individual differences and participation in groups [21], such that community residents gain the opportunity to engage in the planning and execution process for community development through learning and technical assistance [19]. In the case study of PunCar, it is evident that the bottom-up form of participatory design [32] significantly influences "learning the ICT needs in communities" for ICT teaching in rural communities.

In formal teacher training, while teaching lessons on the integrated application of ICT tools and techniques, teachers ought to have strong teaching beliefs, teaching self-efficacy, an enthusiasm for using computers in education and computer self-efficacy [33]. When teachers have high expectations, skills, and access to technology, it is easy for students to learn how to use ICT [34]. In terms of the requirements for being ICT teachers, the Otaku in the PunCar execution team have inherent digital advantages and the enthusiasm associated with a desire to join a non-profit organization. Hence, through a participatory design method, they could communicate with community residents to find the most suitable ICT teaching model for that community. In this process, the PunCar execution team not only plays the role of teacher but also the important role of coordinator. In this way, they are able to successfully integrate the ICT needs of community leader, members, and elders.

(2) **Participatory design in rural community digitization:** The idea of participatory design in community informatics was prevalent in North America in the 1990s. It mainly concerned websites and information systems co-created by the joint participation of community residents, nonprofit organizations, professional information systems staff, and community co-management sections [32]. One of the crucial ideas is the concept of human-centered computing. In Carroll and Rosson's [32] 13-year case study of the Civic Nexus community in Pennsylvania, U.S., through the participatory design of community stakeholders, the community achieved a consensus and division of labor to complete the following work step by step: identifying a need for IT, organizing for an IT Change, learning a new IT Skill, and creating and sustaining intrinsic motivation. The most important accomplishment was establishing community informatics based on the needs of users.

In the past, researchers placed particular importance on the experience in Europe and America, and selected cases mostly in metropolitan areas with higher levels of digitalization. Thus, with the trend towards Web 2.0, the Internet is used to provide platforms through which a network effect can emerge [35]. This study selected rural communities in Taiwan, and aimed to provide them with more innovative and diverse research references in the digital applications involving participatory design in these remote areas.

In this case study, community leader, members, elderly students and the PunCar execution team communicated with each other several times to identify the ICT needs of the community residents, and designed ICT teaching material that best suited local circumstances, which dealt mainly with skills associated with internet applications. Finally, combined with the cultural features of these rural communities, residents co-created or co-edited the Web 2.0 blogs to build up community consensus, increase community attachment, and promoted their communities through digital marketing and social networks, and then forwarded the experience of the exchange to other communities.

Compared to the research results of participatory design in community informatics in Civic Nexus [32], PunCar Action's ICT mobile teaching models have a similar operational process and give presentations in rural communities in Taiwan. However, the latter's level of engagement is higher than that of the former, and therefore has a greater impact on the revival of the rural community.

4.3. Distinctive ICT Courses Suitable for the Rural Elderly and the Revival of Communities

(1) **Dynamic teaching methods to enhance one's confidence in dealing with ICT:** In rural communities, the education of students extends mainly to junior high school, and the most common occupations are farmers, housewives, and immigrant brides. Therefore, teaching methods must be suitably adjusted according to the individual differences of students. In this study, the teacher-student ratio of PunCar Action was an average of one lecturer and approximately two to three volunteers to 15 students. During class, students operated the ICT tools themselves and provided feedback as a means of verifying that they were familiar with the use of ICT tools (including hardware and software).

Rural elders form community learning groups through community clustering; the homogeneity of such groups (similar age, familiarity with each other, similar schedules, contact time with ICT tools)

allows them to overcome their fear of using digital software and hardware. At the same time, the use of local dialects and interactive teaching methods removes the lecturer's authority and allows lecturers to become closer to students and increase their enthusiasm for learning.

(2) **Ames and Youatt [30] stipulated that the most appropriate intergenerational course planning must meet four standards**: meet the objectives of courses or activities; determine the appropriateness of activities; consider the interests and abilities of participants; and assess actual conditions. Through participant observation in this case study, we found that senior citizens in rural communities have a lot of time but are not often accompanied by others. Thus, learning how to operate the computers and type quickly are not necessarily the digital skills they need most. Digital skills are a tool and a means. The purpose is to allow rural residents to go online to make a doctor's appointment, purchase a train ticket, talk with children working in other cities via video conferencing, use digital cameras to take photos and then upload the photos to share with family and friends. Therefore, basic courses focus on teaching the residents of rural communities how to make life more convenient through the use of computers and the internet, because they are such effective tools for connecting with family and friends.

In a study concerned with trends in promoting community development, Toker [36] pointed out that learning the needs of community residents, enhancing their engagement, highlighting public issues, and advancing the level of community renaissance and sustainable development are crucial issues. To allow residents of rural communities to learn more advanced ICT applications, PunCar Action selected the co-creation of community blogs as the focus of advanced courses. The content of the blog is adjusted according to the features of each community, which can be further divided into two categories, reviving the core functions of communities and marketing local industry. Students learned diverse new digital skills in the process of setting up and co-editing their community blogs; the blog enhanced residents' identification with their communities and helped to accomplish the goal of increasing community attachment.

5. Conclusions

PunCar Action uses a bottom-up form of participatory design to reduce digital divide in rural communities in Taiwan. By identifying the information needed to plan the teaching materials and methods of the ICT curriculum, these settings were all accomplished through collaboration and communication among stakeholders, including community residents and the PunCar execution team. The relationships between teachers and learners are close; hence, the content of the courses could be adjusted as required. In the case study, a collaborative concept of participatory design was implemented on Web 2.0 open platforms. This enabled elderly ICT learners to co-create and maintain community blogs, and perform the ICT skills they acquired with these social media, such as posting the records of community activities online. These applications help promote the benefits of community revival.

Based on this study's analysis of ICT learning in rural communities in Taiwan, programs by non-profit organizations aimed at reducing the digital divide, such as PunCar Action, include participatory design features and mobile intergenerational ICT education models with high penetrability.

In addition, the emphasis on interpersonal communication, informational applications and the requirements of residents indeed help to close the last mile of digital divide.

With respect to the urban–rural digital divide reduction and ICT intergenerational education for the elderly, the results of this case study provide a new starting point in the field of adult education, which aims at an innovative model using a non-quantitative index to measure ICT learning performance. Meanwhile, to reduce digital divide, this study also suggests an implementation process that would be more effective in achieving e-Inclusion. These represent the main contributions of this study to ICT adult education in rural communities.

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Conflicts of Interest

The author declares no conflict of interest.

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