


Article

Scientific Information System for Silk Road Education Study

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Abstract: In this paper, we present a scientific information system for the Silk Road education study. The proposed information system includes martial arts, dance, and play of seven countries (Korea, Japan, China, Mongolia, Kazakhstan, Uzbekistan, and Iran) of the Silk Road. The purpose of the information system is to promote convergence education for university students by providing a fundamental framework of the information system and traditional cultures. The basic concept of the information system can help university students to develop information and communications technology skills and to develop their own applications by collaborating with each other as a team. In addition, while developing the information system of martial arts, dance, and play of seven countries of the Silk Road, university students will understand the connection between traditional cultures and modern cultures of the Silk Road.

Keywords: scientific information system; ICT Education; Silk Road; IT convergence

1. Introduction

The Silk Road or Silk Route was a historical trade route which linked the regions of the ancient world in commerce, and the trade through the Silk Road played an important role in civilization development for many countries (Korea, Japan, China, Europe, Africa, Arabia, Iran, India, etc.) [1,2]. The basic notion of the Silk Road is related to the terrestrial and seafaring routes for these countries [3]. In addition to the economic reason, the Silk Road reflected ethnic, national, and cultural trade across the countries in a positive way [4,5].

To maintain and seek the planet's geological heritage and to encourage the sustainable research and development of the heritage, UNESCO established the Global Geoparks Network (GGN) in 1998 [6,7]. The main objective of the GGN is to emphasize the usefulness of the sustainable development of local and global populations. Along the same line, our objective is to highlight the importance of cultural heritage (martial arts, dance, and play) of the Silk Road.

By paying attention to and educating on intangible heritage, such as martial arts, dance, and play of the Silk Road, potential gains are great for countries, regardless of the level of international integration. We can observe past society and that will be a clue to national history; one can share national characteristics and their ethnicity through sustainable development and education and, therefore, promote a balanced development of national cultures with harmony between traditional and modern societies.

The history of humankind is based on belief in religion [8]. The development of humankind has been in sync with folk religion, and many scientific theories stem from religious introspection. That is, science and religion are fields of learning about the universe in diverse ways, not in a confrontation relationship. The spirit of religion is in harmony with history; at the same time, martial arts, dance, and play are the physical activities of that.

Humans enjoy various kinds of martial arts, dance, and play and they are closely related to human life [9]. Physical activities of cultures have led to sports for the countries [10]. The countries of the Silk Road were developed with international exchange and participation. These exchanges have influenced people in all areas of life. In our society, we can continue cultural exchanges regardless of the border across the countries with the help of the Internet and information and communications technology (ICT) [11,12].

In fact, we need a better understanding of harmony and unity throughout the global community [13]. In this regard, understanding martial arts, dance, and play of the Silk Road can be an important tool to dissolve the barriers between countries through physical and emotional communication. Hence, studying the various martial arts, dance, and play of the Silk Road will help to understand cultures and connections between tradition and modernity.

In the last decade, the concept of big data and its related technologies have been received with lavish attention from both industries and academia, since big data can resolve the concerns of data acquisition, efficient data processing, and sustainability of business strategies and policies [14]. In this regard, our prime intention is to identify vital points for using big data through the information system, providing it with the opportunity to enhance the positive results of sustainable use of data and information, while developing valuable educational procedures in the forthcoming knowledge and strategies.

The knowledge economy can be considered the outcome of entities, where all participants involve data and information exchange, assuring long-term survival. By extending it to the global perspective, our society can be defined as a system, where individual actors perform sharing and exchanging processes of information. These procedures help to maintain each individual member's sustainability of their educational courses and strategies based on the information supplied by external sources.

In this respect, Higher Education in universities can influence these effects in a positive way [15]. One of the best solutions to this problem is to have an affirmative concept of the promising contribution, in which individual actors in universities are able to share a common strategy for enhancing cultural and sustainable development, based on their examination and evaluation, regardless of their race or gender [16].

In this paper, we focus on the Silk Road education study, especially for culture and arts. For culture and arts education of the Silk Road, we study martial arts, dance, and play for seven countries (Korea, Japan, China, Mongolia, Kazakhstan, Uzbekistan, and Iran). Based on the accumulated resources, we build the information system of martial arts, dance, and play of the Silk Road in order to promote convergence education for university students. The building procedures of the information system can be used for both major and non-major university students in convergence education to promote ICT skills [17,18].

Contributions of this paper can be summarized as follow:

- We establish a firm foothold on martial arts, dance, and play of the Silk Road for culture and arts education, which can act as a stepping stone into the world of integration;
- The information system can help university students to understand ICT skills and to develop their own applications by collaborating with each other as a team;
- The developed information system will be used for elementary/middle/high school students or kindergarten kids in physical education to maintain and improve their physical conditions and movement, at the same time offering pleasure to the participants.

The roadmap of the paper can be summarized as follows: Section 2 discusses the education discipline and database organization/design and provides the milestones and curriculum for lectures. Section 3 presents the prototype results for the web-based programming, and mobile application with database integration. Section 4 discusses the rationale for designing the proposed information system and design plan for project-based learning. Section 5 concludes the paper and proposes curriculum recommendations based on our results.

2. Materials and Methods

2.1. Education Discipline

Countries of Eurasia have their own martial arts, dance, and play [4,19,20]. To estimate their transformation, appropriate references are needed and, therefore, a trawl is required to understand the connection between traditional cultures and modern cultures [21]. In this regard, we have studied martial arts, dance, and play for Korea, Japan, China, Mongolia, Kazakhstan, Uzbekistan, and Iran.

The rationale for developing the information system for martial arts, dance, and play is as follows: First, martial arts, dance, and play of the Silk Road's seven countries are not fully investigated, and some of them are conflicting or absent. Second, we sometimes overlook the detail of traditional cultures and diversity of historical origins. Third, the effort to accumulate a historical library and data for the Silk Road is incomplete. Thus, studying them is required to meet the demands of sustainable education.

Not only do we need to understand the historical connection, but it is also necessary to build the database for them to promote their cultures [22]. Hence, it is imperative for university students to learn the seven countries' martial arts, dance, and play to understand their connection and relationships. To this end, we provide the information system of martial arts, dance, and play for convergence education targeting university students.

Skills associated with ICT are increasingly taken for granted at all ages [23]. However, ICT-based education has not been broadened considerably in the past decades for non-major university students in Korea [24]. As the fourth industrial revolution has emerged as one of the biggest issues in Korean society, the Korean ministry of education activates convergence education by linking ICT to other departments and curricula [25].

To catch up with the fourth industrial revolution and convergence education, we present the information system for university students. By providing a fundamental framework of the information system, we can enable university students to develop ICT skills and learn the connection between traditional cultures and modern cultures of the Silk Road.

We considered science-, technology-, engineering-, art-, and mathematics-based (STEAM) [26] education study for martial arts [27,28], dance [29–31], and play [32,33]. The STEAM-based programs aim to provide students with critical thinking and creative approaches to real-world problems, using ICT, engineering, mathematics, or arts [34].

2.2. Database Organization and Design

In this subsection, we describe the detailed organization and design principles of the information system of martial arts, dance, and play. In the education discipline, we extend the STEAM by including physical education [35]. More specifically, by developing the information system, instructors and learners of physical education can utilize the information system to understand their martial arts, dance, and play. Moreover, to promote ICT skills, the building procedures of the information system can be used for both major and non-major university students. To construct the database for the information system, we researched 14 to 20 subjects per country for martial arts, dance, and play. For seven countries, 117 subjects were integrated into the information system. The list of the subjects is shown in Table 1.

Table 1. The list of martial arts, dance, and play.

Korea	Japan	China	Mongolia	Kazakhstan	Uzbekistan	Iran
Taekwondo	柔道	長兵器武藝	МОРИНЫ УРАЛДААН	Kokpar Tartu	Kupkari	Zurkhanei
Taekkyon	剣道	長兵器武藝:棍棒類	БӨХ	Audaryspak	Tyiyn Engmey	Koshti Pahlavani
Ssireum	弓道	短兵器武藝:刀, 劍	СУР ХАРВАА	Bayga	Jang Sanati	Kung Fu To'a
Martial Arts on Horseback	空手道	徒手武藝:内家拳, 外家拳	БИЕЛГЭЭ	Kazakh Kures	Kurash	Iranian court dance
Korean Polo	合気道	徒手武藝:摔角類	ЦАМ	Kures	Bukhara	Dances of Khorasan
Korean spearmanship	日本少林寺拳法	弓術	ҮДГАН БҮЖИГ	Kara-Zhorga	Khorezm	Persian dance
Korean swordmanship	薙刀	馬上武藝	БӨМБӨРТЭЙ БҮЖИГ	Angshluk	Fergana	Chahar Shanbeh suri
Korean Archery	銃剣道	中國式 wrestling	НҮҮДЭЛЧИН БҮЖИГ	Kyz Kuu	Surkhan	Kolah barak
Chukkuk	相撲	練功十八法	ээж мод	Aigolek	Ram fighting	Tanab keshi
Cheongdo Bull Fight	古武道	氣功	Boriyad	Ak suyek	Cock fighting	Haft Sang
Pyun-ssam	三味線	萨吾尔登	БҮЛЭГ БҮЖИГ	Assyks	Narde	Beshin Pasho
Mask dance	阿波踊り	顶碗舞	高壘	Altybakan	Besh tosh	Vasati
Sword dance	歌舞伎 かぶき	盅子舞	ШАГАЙ ХАРВАХ	Altyn kabak	Chillak	Sham Gol Parvaneh
Cheoyoung dance	琉球舞踊	孔雀舞	Монгол Шагайн Харваа	Togyz kumalak	Lanka	Khoros Jangi
Dodanggut	神樂	蠟條舞				Polo
Jinogigut	ブランコ	蹴鞠				
Playing on the swing	石合戦	擊毬				
Korean Seesaw	綱引	投壺				
Jegichagi	蹴鞠	秋千				
Ganggangsullae	羽根突	水嬉				

One of the fundamental ICT skills to construct the information system was the database. Figure 1 shows the database organization and structure of the information system. There were four steps in the lifecycle of the database. The first step was data integration and digitalization for contents of martial arts, dance, and play. Then, we categorized and classified the contents by country. This classification can be useful when developing web applications and mobile services. Step 3 was the database system construction. Based on the collected data, we could construct the database system for applications. At this step, we extended the database by including similarity and difference between items. Finally, the database system service was implemented and operated with developed applications.

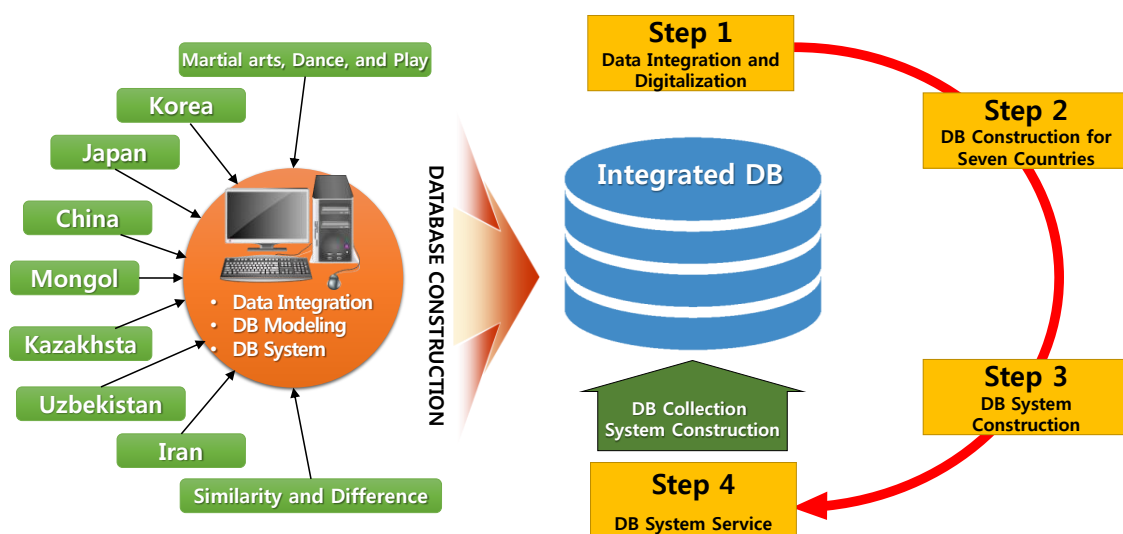
**Figure 1.** Database organization and structure.

Figure 2 depicts the detailed database design and specification. The prototype of the database contains four tables, that is, Nation, Type, List and Comparison. The Nation table has two attributes

(i.e., ID and Nation_name). In our database design, there are seven tuples for that Nation table since we collected data of martial arts, dance, and play for seven countries (Korea, Japan, China, Mongolia, Kazakhstan, Uzbekistan, and Iran). The structure of the Type table is similar to the Nation table. The Type table includes two attributes (i.e., ID and Type_name). Each item is classified as one of the three categories: Martial arts, dance, or play. Hence, three tuples exist for the Type table. The Type table is useful when we compared two items for similarity and difference.

Field Name	Data Type
ID	AutoNumber
Nation_name	Short Text

Field Name	Data Type
ID	AutoNumber
Type_name	Short Text

Field Name	Data Type
ID	AutoNumber
Item_name	Short Text
Nation	Number
Type	Number
Description	Long Text

Field Name	Data Type
ID	AutoNumber
Item1	Number
Item2	Number
Description	Long Text

Figure 2. Database table design.

The List table is the primary table for the database. Since each item has nation and type values, we added the Nation and Type attributes as foreign keys. By adding the Nation and Type attributes as foreign keys, we could minimize the duplicated text data and maintain integrity. The data type of the Description attribute of the List table is Long Text as Short Text type stores up to 255 characters. The Comparison table has two foreign keys, that is, Item1 and Item2 and the Description attribute as Long Text. Note that the four tables have the ID attribute as the primary key. Figure 3 shows the relationship of the four tables. For the Comparison table, the Item2 attribute is a foreign key by referencing the List table (List_1 indicates the List table).

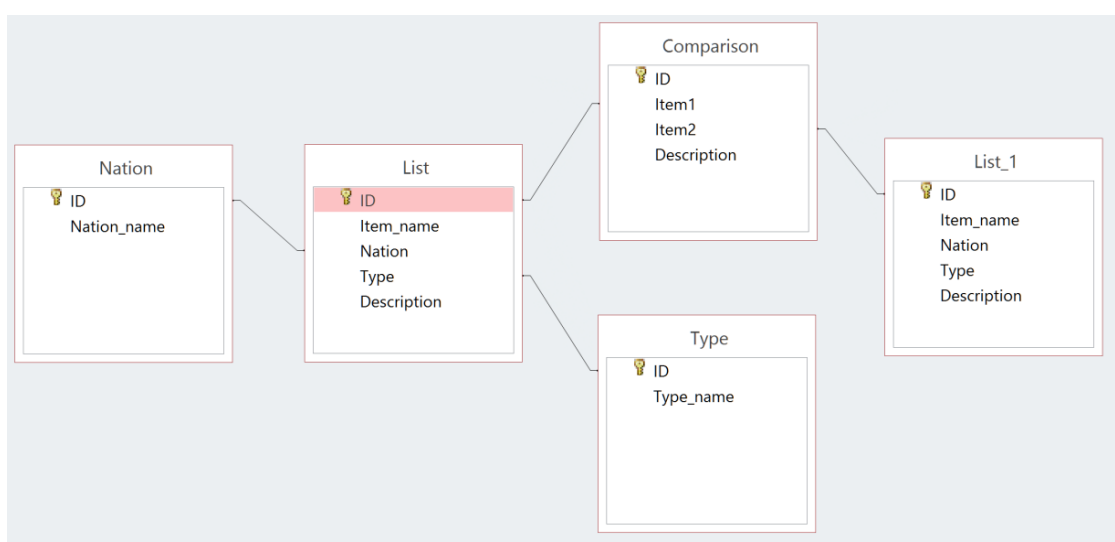


Figure 3. Database relationship.

2.3. Milestones and Curriculum

The course materials and contents are based on Windows platform environments with free software. Therefore, students can install the software and develop the project free of charge at home.

Table 2 lists the milestones for the course to help students to build the lab environment. Milestone #1 is to install the web server and database management system (DBMS). More specifically, the students are required to install the Apache web server [36], MySQL DBMS [37], and Hypertext Preprocessor (PHP) [38]. After installing the web development environment, the next step is to connect to the MySQL DBMS with HTML5 and PHP. This step is provided to the students as milestone #2 for 2 weeks. PHP 5 and its later versions are compatible with a MySQL database using the MySQLi extension and PHP data objects (PDO). Note that before PHP 5, older packages supported the MySQL extension, but this library was deprecated. MySQLi and PDO support the object-oriented programming style, in addition to functional application programming interfaces (APIs). To prevent structured query language (SQL) injection attacks [39,40], they support secure statements. Milestones #1 and #2 are designed for developing a web application of martial arts, dance, and play of the Silk Road before mid-term examination.

Table 2. Milestones for the course.

Milestone	Description	Programming Language	Duration
#1	Installing web server and DBMS	N/A	1 week
#2	Connecting Database with PHP	HTML5, PHP	2 weeks
#3	Installing Android Studio	N/A	1 week
#4	Interacting with SQLite	Java, SQL	2 weeks

After mid-term examination, the course proceeds to developing a smartphone application. Therefore, milestones #3 and #4 are based on Android studio [41]. Since Android applications are based on Java, the curriculum also provides Java basics for 2 weeks. The details of the curriculum are listed in Table 3. Milestone #4 is for interacting with the Android application and SQLite [42], which requires minimum configuration thanks to its server-less architecture [43].

Table 3. Curriculum for the course.

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Lectures	Course Intro	Introducing martial arts, dance, and play of the Silk Road		HTML5, CSS3, Javascript Basics		Developing Web Application		Mid-term Exam	Java Basics		Android Studio Basics	Developing Application with SQLite		Final Exam		
Milestone				#1	#2					#3			#4			

3. Results

In this section, we describe how the database design can be extended to various platforms and applications. The web is a notable and popular information system platform. To work with a database in web-based programming languages, server-side programming is required. Of the server-side programming languages available, we used PHP, which is a widely used, free, and efficient language for web development.

PHP code can be embedded into HTML5 code and is usually processed by a PHP interpreter. When a client enters a uniform resource locator (URL), the web browser requests the URL via the Internet. When the front-end of the web server receives the user's request, it forwards the request to the script engine. After examination of the request, the script engine retrieves the source file (e.g., index.php) from the file system of the web server. Then, it processes the source file, possibly with the DBMS. Next, the script engine generates the result as HTML codes. The generated HTML codes are delivered to the client's web browser via the Internet.

Figure 4 shows the search form and its result of the web application. Specifically, the figure illustrates the search result of Taekwondo. Based on the implementation of the information system in web programming, we can search by name, type, or nation. Note that the results may have multiple rows when multiple tuples are matched. For the smartphone application, the database and its relational

tables are exported to SQLite. Figure 5 depicts the database structure of martial arts, dance, and play of the Silk Road for SQLite.

Martial arts, Dance, and Play of the Silk Road

☒ Name ▼

☐ Type ▼

☐ Nation ▼

Number	Name	Description
1	Taekwondo	Taekwondo is a Korean martial art, characterized by its emphasis on head-height kicks, jumping and spinning kicks, and fast kicking techniques.

Figure 4. Database relationship.

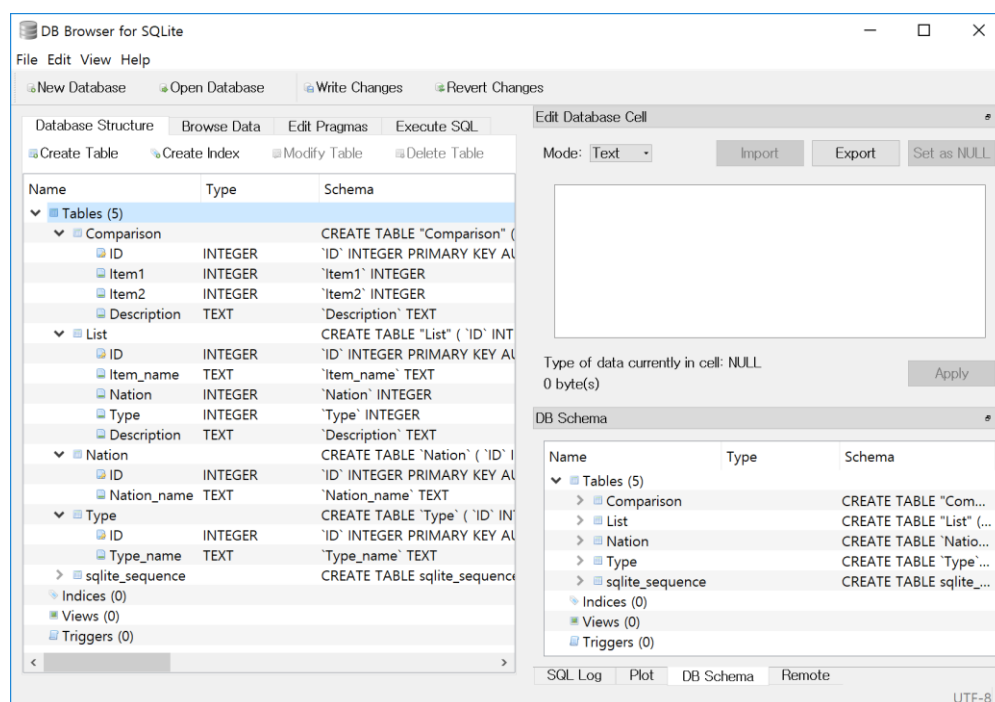


Figure 5. Database structure for SQLite.

Figure 6 represents the Android application for martial arts, dance, and play of the Silk Road. By deploying the mobile application for martial arts, dance, and play of the Silk Road, it provides users instant access to the contents in a user-friendly fashion. By constructing and implementing the information system of martial arts, dance, and play of the Silk Road, university students performing convergence education are able to learn various programming languages and ICT skills from SQL for a database to HTML, cascading style sheets (CSS), JavaScript, and PHP for web development, as well as Android (Java, SQLite) for mobile applications.

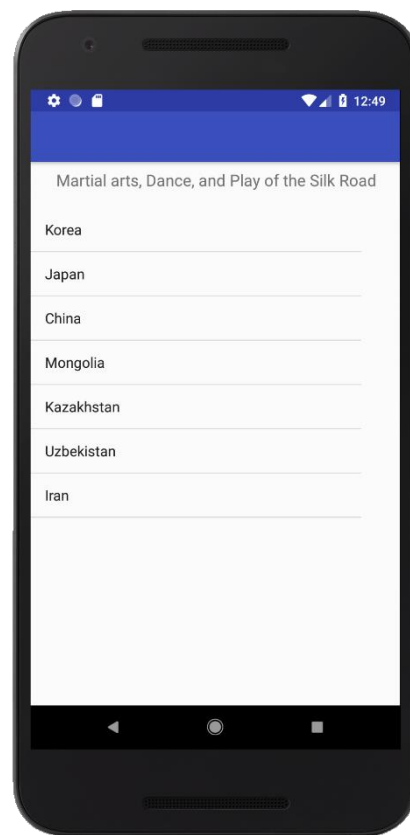


Figure 6. Android application for martial arts, dance, and play of the Silk Road.

4. Discussion

Human cultures repose on a revival of trade and exchange. By being in contact with another culture, we encounter both conflicts and harmony, which lead to the cultural development and evolution of civilization. With these processes, we can inherit and develop cultural traditions by accepting foreign cultures. Therefore, foreign cultures have also influenced our historical results. In this regard, it is necessary to understand all the cultures of other countries.

Nevertheless, some of the cultures related to physical activities, including martial arts, dance, and play dissipate in some countries. As globalization advances, two sides coexist for cultures. One is to promote traditional cultures, and the other is to exclude them for the purpose of modernization. As demands for succession to traditional cultures and physical activities increase, it is time to prioritize the former.

There are reasons for promoting and maintaining traditional cultures from the viewpoint of cultural history. Humans' physical cultures appeared and spread in different ways because of self-production and imitation properties. The Silk Road played an important role in the embracement and development of cultures, in addition to the traffic route of the trade. By the virtue of the Silk Road, our culture has been changed in both regional and ethnic ways.

Studying and researching martial arts, dance, and play can construct a public society by promoting mutual understanding of region and people. Traditional cultures are the basis for constructing the identity of groups or individuals. One can enjoy traditional cultures since they are public in nature and, therefore, can be shared with everyone. Eventually, we can acknowledge the variety of human societies and cultures, and inherit cultures creatively.

Although the information system is currently designed for university students in convergence education, we plan to upgrade gradually by giving university students projects as a team. We believe that this enables them to develop a sense of cooperation as well as ICT skills. The long-term outlook for developing the information system is promising. First, we establish a firm foothold in martial

arts, dance, and play of the Silk Road, which can act as a stepping stone into the world of integration. Second, by developing the information system for martial arts, dance, and play of the Silk Road, university students can develop ICT skills and learn cooperation. Third, the developed information system will be used for elementary/middle/high school students or kindergarten kids in physical education to maintain and improve their physical conditions and movement, while offering pleasure to the participants. Lastly, the information system supports multi-platforms and smart devices (personal computers, laptops, tablets, and smartphones), which supports learning environments anytime, anywhere.

The prototype of the information system can be stored and processed in local systems. Therefore, the data can be accessed for classroom students. To enhance accessibility and collaboration, we are planning to extend the platform to the cloud computing system [44,45]. Additional benefits of using cloud computing for ICT-based learning are reliability and efficiency. Project source codes and executables can be stored in the stable storage [46].

For project-based learning [47,48], we guide the students through stressful processes and make them competent in tackling the problems. There are five phases to the guideline. Phase 1 is analysis. In the analysis phase, the students are asked to break the problem into smaller subjects to understand it in detail. Then, they are asked to list the requirements of the smaller problems to determine the needs and conditions, by taking account of conflicts for other problems.

Phase 2 is design. In the design phase, they are asked to sketch a diagram for visualization and relationships among pieces of the problems before programming. Then, they are asked to organize the program codes, including variables, functions, object oriented design, file structures, etc. During this phase, each team member is involved in the discussion to embrace one another's opinion. Phase 3 is development. Based on the diagram of phase 2, individual team members write the program codes.

Phase 4 is running and debugging. It is hard to implement the perfect program codes for the first time. Therefore, the students need to find syntax errors and logical errors. Thankfully, syntax errors can easily be found with the help of the integrated development environment (IDE). The difficult part is to find logical errors, since there is no indication in the IDE. To find a bug in the program, the students will perform the debugging process provided by the IDE. Then, they investigate the variables step-by-step by pointing breakpoints. Alternatively, they can draw a trace table for each step of the program codes. After implementation, the final phase is documentation. To better maintain the program, they write comments and reports to avoid poor code readability for their team members.

To improve academic achievement, we emphasize the following four things: Learning motivation, practicableness of learning, problem-solving techniques, and systematic design and development. One of the important principles of project-based learning is to give learning motivation. To this end, the students are given the opportunity to seek the reasons why the problems are important, and their attention is kept through interesting lecture materials.

The second thing is the practicableness of learning. The lecture is based on both theory and practice. Therefore, the problems can be solvable in programming languages. By letting the students solve the problems logically, they will feel a sense of accomplishment. To provide a sense of accomplishment, we give lectures on problem-solving techniques. By splitting the problem into smaller ones, the students can think about the structure of the hierarchy of the problem. Then, they solve easy, smaller problems one-by-one, and eventually conquer the problem.

The last thing is systematic design and development. Because of the limited lecture hours, the course itself should be systematic. Not all the contents of the course can be introduced in the classroom and, therefore, some of them can be included in the homework and project. Nevertheless, the core concept and basic materials must be given in the classroom with a clear explanation. What is more, discussion time should be given for difficult subjects between student–student and student–instructor or vice versa.

The proposed design and architecture of the information system reveal that the cultural information of martial arts, dance, and play of the Silk Road can influence the students' dimension by

developing the information system. This influence can also be passed down to their juniors. The juniors will inherit the seniors' source codes, contents, database, and reports. Hence, the information system can be sustainable with time. Furthermore, the information system will be improved gradually by added contents.

From this point of view, changing the information system for martial arts, dance, and play requires an understanding of the existing architecture based on a top-down approach. To enhance and build the information system, the students also require a bottom-up approach to software engineering. These iterations help students to develop problem-solving thinking as programmers and software architects.

The challenge in developing the information system is to cooperate with others by performing team-based projects and taking responsibility. By doing the team-based projects, each member of the teams can learn thoughtfulness and responsibility. With periodic student presentations, the instructor can give advice and progress directions. In the following semester, the juniors have access to the seniors' data from the previous course. In this way, the information system can be enhanced and enriched with sustainable education.

Traditional cultures are the basis of forming the identity of our society and have sustainable values. They are intrinsically shareable and communicable in nature, and therefore traditional production influences our daily lives and culture. People have the capability of the power of cultural creation, with which we can maintain and inherit folk cultures from region to region in a creative way. This implies that our study will support the transmission of traditional cultures from generation to generation and lay the foundation to produce a brave new world in harmony with modern cultures.

5. Conclusions

A short-term development of the information system may not offer sustainability, although it is related to ICT skills. In our education design, however, the developed source codes, architecture, and reports can be passed down to the juniors in the next semester. In this way, it is possible to develop a sustainable approach to developing the information system. This approach is promising because it requires a change in the architectural models and contents of the information system, while it offers many relevant ICT skills. The course plan is provided with problem-solving and computational thinking processes, which are emphasized requirements in the fourth industrial revolution era. In this way, we can improve convergence education and ICT skills with constant practice for developing the information systems, whose main contents are valuable intangible heritage.

In this paper, we presented the scientific information system of martial arts, dance, and play of seven countries (Korea, Japan, China, Mongolia, Kazakhstan, Uzbekistan, and Iran) of the Silk Road. By researching 14 to 20 subjects per country, we built the database to implement the information system. The building procedures of the information system can be used for both major and non-major university students in convergence education to promote ICT skills. While developing the information system of martial arts, dance, and play of the Silk Road, university students will also understand the connection between traditional cultures and modern cultures of the Silk Road. We recommend that the curriculum contain theoretical background materials and enough practice hours. In addition, in consideration of non-major students, the curriculum can be divided into two subjects: One for theoretical lectures and the other one for practice lectures.

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