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建立以 SCORM 為基礎整合人物時間空間之歷史教學系統(第 3 年)
研究成果報告(完整版)

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行政院國家科學委員會補助專題研究計畫 ■ 成 果 報 告 □期中進度報告

建立以 SCORM 為基礎整合人物時間空間之歷史教學系統

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計畫參與人員：張准榕、杜筱涵

成果報告類型(依經費核定清單規定繳交)：□精簡報告　■完整報告

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執行單位：中華大學資訊管理學系

Abstract

HES-SPATO, a history educational system was developed. It is unique in that it integrates the indispensable elements of history events such as person, space, and time for increasing the understandability of complicated history learning materials. It was based on SCORM, to ensure reusability, durability, accessibility, and interoperability of electronic materials. During the three years, the architecture, authoring module, and learning module were developed. In HES-SPATO, history SCOs were formed by integrating SPATOs with the associated “Space”, “Person”, and “Action/Attribute” assets, stored in the Asset Pool. SCOs, then, formed other SCORM components such as lessons and courses accordingly. Since not all course designers and instructors are skilled at information technology, so that they are limited in creating electronic history learning materials in most cases. The authoring module of HES-SPATO, which is designed to be used by courseware designers and instructors, was developed. With the authoring module, HES-SPATO can enhance the history courseware designer and instructor’s ability for creating online materials in a few guided steps with flexibility. The learning module was developed by applying the temporal logic and the GIS concept of information layers. With application of the temporal logic to reason the temporal relationships between history events, HES-SPATO makes it possible to present history events in sequences with animation to clearly illustrate the dynamics of history events. With the learning interface, students can select features, displayed with different layer, to realize history events more clearly, in the manner they want, zoom in to see features at closer range, view variety supplement learning materials at the same time, and view SCOs according to his own progress and steps. Also, the interface can only display space information directly related to the history event, as defined in SPATO, to reduce the problem of cognitive overload. Experiments were conducted to evaluate the system and positive feedback was obtained. So far, two journal and three international conference papers have been published for this project.

Keywords: history educational system, SCORM, GIS, spatial-temporal model, authoring module, learning module, temporal logic

1. Introduction

Traditionally, students acquire history knowledge from hardcopy textbooks. They are usually lost in the geographical space and confused about the relationship between different history events. A history event includes information about “who initiated the event”, “what happened”, “when it happened”, and “where the event happened”. If presenting all information about the event in multiple formats at the same time, students will understand the relationships among history events more efficiently and effectively.

Currently, lots of historical materials are delivered on Internet. Since history is highly related to geographical space, some researchers included geographic information into history educational

systems and developed their systems based on GIS (Geographic Information Systems). Applying GIS concepts is useful for spatial information integration. Through the bridging of time and space, and by efficiently gathering, saving, editing, managing, analyzing and displaying every form of spatial information, it can successfully integrate various types of spatial data and digital information management system, and further demonstrate the values of data in different views (Liao et al., 2004; Lo, 2004). Those systems can store, retrieve, map, and analyze geographic information about history, hence, increase the understandability. However, history events happened in sequences. Without presenting related information of history events step by step may cause the problems of information and cognitive overload. Person is the most important element for history events and is indispensable to history. Therefore, not only the spatial and temporal components but also the person component should be included in the history educational system model.

Not all history experts and instructors are good at information technologies so that they cannot easily create electronic history learning materials. The ability of computer operating is a bottleneck of history instructors so that only few products exist nowadays. Design and development of standards need to be put in place to ensure consistency and transferability of skills. Designers and developers of on-line learning materials may have variety of software tools for creating learning resources. These tools range from presenting software packages to more complex authoring environments. They can be very useful in allowing developers the opportunity to create learning resources that might otherwise require extensive programming skills. The Sharable Content Object Reference Model (SCORM), part of the Advanced Distributed Learning (ADL) initiative, promotes efforts to create flexible learning materials with reusability, durability, accessibility, and interoperability. The goal of SCORM is to create flexible learning materials by ensuring content that is reusable, interoperable, durable, and accessible, regardless of the content delivery and management system. SCORM achieves its goal with the use of SCOs (Sharable Content Object) that are composed of assets. In order to identify SCO, assets, or any other kinds of learning materials, ADL proposed “meta-data”, which means “data about data”, to identify and locate learning materials by managers, learners, designers, programmers and other interested in education and training (Learning Systems Architecture Lab, 2003). Based on SCORM and the GIS concepts, HES-SPATO, a SCORM-based spatial-person-temporal history educational system architecture has been developed by Lo et al. (2007). This paper further proposes the authoring module of HES-SPATO, which is designed to be used by courseware designers and instructors. With this authoring module, designers and instructors can create their own learning materials and courseware in a few guided steps with flexibility.

2. The SCORM-Based History Educational System Architecture

The proposed history educational system is based on SPATO (Spatial, Person, Action/Attribute, and Temporal Object), adopted from Raza and Kainz’s SATO [8]. Hence, the

proposed system is named HES-SPATO (History Educational System based on SPATO). The HES-SPATO architecture has nine components as illustrated in Figure 1.

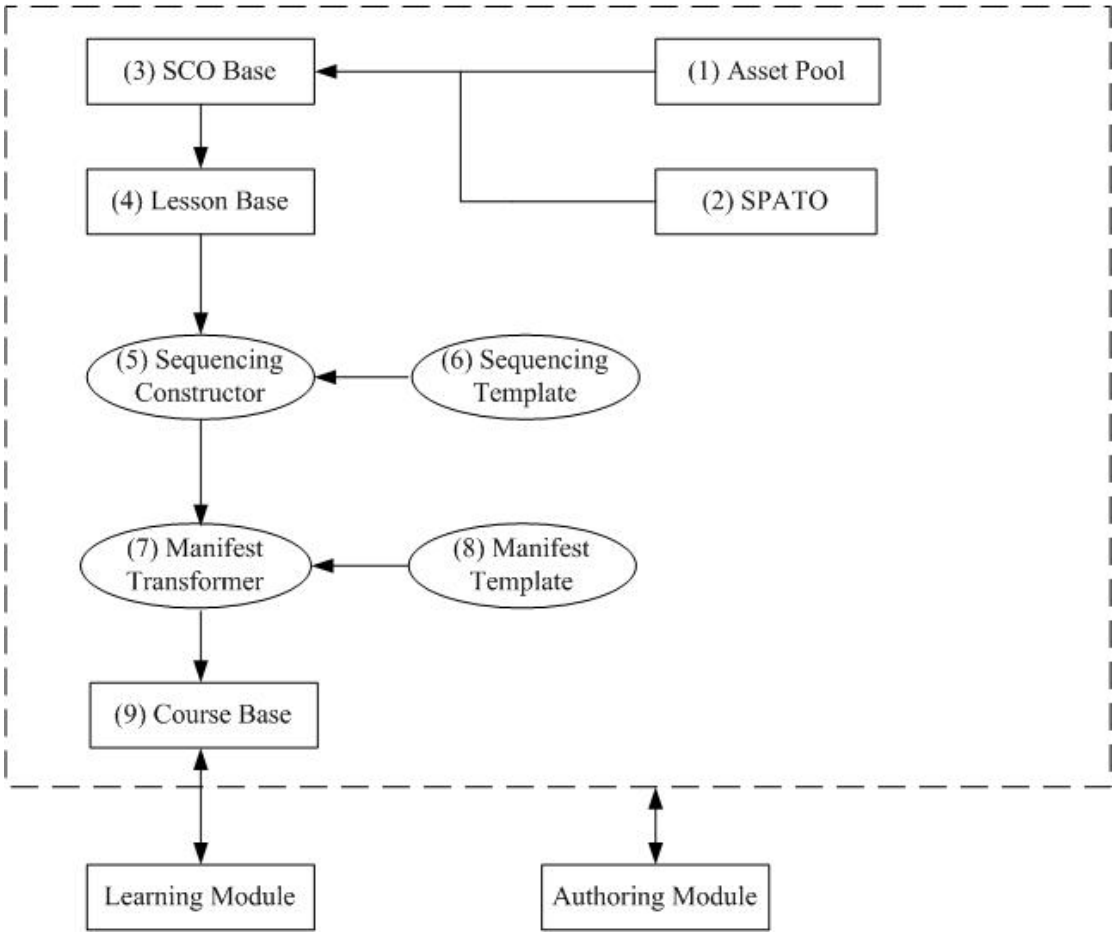

Figure 1: HES-SPATO Architecture

The nine components in the proposed system are Asset Pool, SPATO, SCO (Sharable Content Object) Base, Lesson Base, Sequencing Constructor, Sequencing Template, Manifest Transformer, Manifest Template, and Course Base.

(1) Asset Pool stores all types of assets developed by learning material designers or imported from other Internet sources. An Asset is the smallest physical unit in SCORM. It can be represented by any electronic format such as text, image, sound, Web page, assessment objects, and other pieces of data that can be delivered to a Web client [5].

(2) SPATO is an object to specify “where”, “who/whom”, “what”, and “when” about history events. A history event includes space (where the event happened), person (who caused the event/whom the event influenced), action (what the event was), and time (when the event happened). SPATO is a logical object rather than a physical file in HES-SPATO. It presents the elements of a history event by integrating assets stored in the Asset Pool. A SPATO includes pointers for linking “Space”, “Person”, and “Action/Attribute” assets to form a learning object. It is able to present history events in animation along the historical timeline

when these assets are integrated with the “Time” component specified in SPATO. As the definition of SCORM, animation is also an asset type. Therefore, SPATO can be defined as an asset. However, it is not a traditional animation like flash or movie. A SPATO can overlay or combine other SPATOs. It is much more sharable, flexible, and integratable than traditional animations.

(3) SCO Base stores learning objects used in the system. The associated “Space”, “Person”, and “Action/Attribute” assets, stored in the Asset Pool, are integrated into SPATO to form a history learning object. All learning objects follow the SCORM standard. A SCO can exist alone and is the smallest logical unit in HES-SPATO. Same event can be presented by multiple SCOs.

(4) Lesson Base is used to manage lessons combined by SCOs in the SCO Base. A lesson may include one or more SCOs. A chapter or a section in a course is regarded as a lesson. All lessons belong to SCORM content aggregations. Courseware designers create a lesson by selecting and organizing SCOs in the SCO base. If a lesson has multiple SCOs, it implies that there exists a relationship, such as before, after, contain, etc., among these SCOs in the time dimension and the courseware designer wants to present such relationship in the lesson. Therefore, students can view history SCOs, whose temporal attributes of history events were defined in SPATO, in sequence. In HES-SPATO, SPATOs of different SCOs can be integrated into a SPATO, therefore, students can view an animation which includes multiple history events.

(5) A course is composed of two elements, lessons and sequential relationships among lessons. Lessons are defined in Lesson Base and the sequential relationships are defined in Sequencing Constructor. In Sequencing Constructor, courseware designers define the relationships among lessons by sequencing objects (SO) which are provided by Sequencing Template. After defining the relationships among lessons, the layout of a course is defined in Manifest Transformer.

(6) Sequencing Template provides SOs to the Sequencing Constructor for designing the relationships among lessons. In HES-SPATO, two types of sequencing templates, forward and choice, are provided.

(7) A manifest is a document that contains a structured inventory of the content of a package [5]. In Manifest Transformer, the layout of each lesson is defined by using the template provided by Manifest Template. After designing the layout of a lesson, HES-SPATO will translate the course structure into a Web file and store the file in Course Base.

(8) Manifest Template provides manifest templates to Manifest Transformer for designing the layout of a lesson. In HES-SPATO, three types of manifest templates, two, three, and four frames, are provided.

(9) Course Base stores and manages course files accessed by students. Students study history by navigating the course files stored in Course Base.

3. Authoring Module of HES-SPATO

Authoring module is designed to be used by courseware designers and instructors. With this authoring module, designers and instructors can create their own courseware and learning materials in a few guided steps with flexibility.

3.1 Asset Authoring

The flowchart for asset authoring is illustrated by Figure 2. A friendly authoring interface is developed to guide designers to create assets (Figure 3). Different from multimedia assets (image and audio), designers can create text assets by either importing existing electronic documents or inputting texts through the authoring interface. In HES-SPATO, hyperlinks are provided to navigate related Web site outside the system (Web page assets). To develop Web page assets, designers edit metadata of Web page assets, and then input the related data such as “URL”.

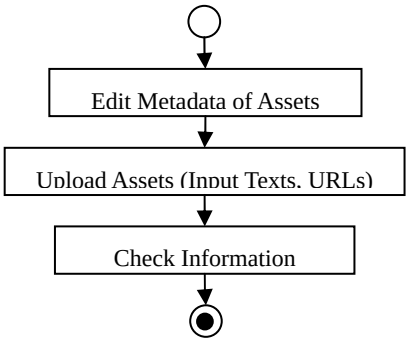

Figure 2: The Flowchart for Asset Authoring

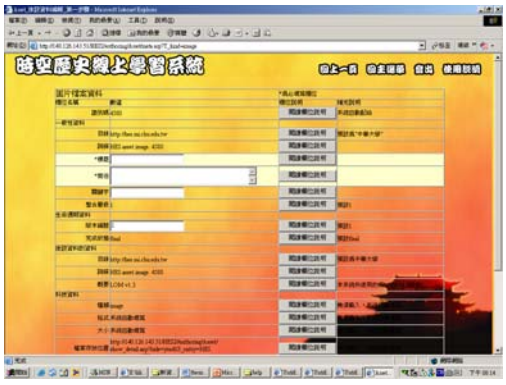

Figure 3: A Sketch of Authoring Interface for Creating Image Assets (Edit Metadata of Assets)

Unlike image, audio, and text assets, person, space, and action/attribute assets are structured. For example, a person asset may include structured data such as “name”, “nationality”, year of birth”, “year of death”, etc; A space asset may include structured data such as “space name”, “location”, “year of start”, “year of end”, “category”, etc. An action/attribute may include structured data such as “action name”, “number of soldiers in a troop”, etc. **錯誤! 找不到參照來源。**Figure 4 shows the flowchart for person asset authoring and Figure 5 illustrates the

sketches of authoring interface for creating person and space assets.

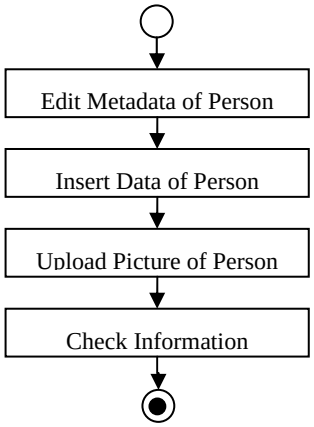

Figure 4: The Flowchart for Person Assets Authoring

Figure 5: A Sketch of Authoring Interface for Creating Person and Space Assets

3.2 SPATO Authoring

A SPATO is composed of four components, SpatialClass, PersonClass, Action/AttributeClass, and TemporalClass. It includes pointers for linking “Space”, “Person”, and “Action/Attribute” assets to form a history SCO which is able to present history events in sequences along the historical time line when these assets are integrated with the “Time” component. The flowchart for creating SPATO is illustrated in Figure 6 and Figure 7 illustrates the authoring interface for creating SPATOs.

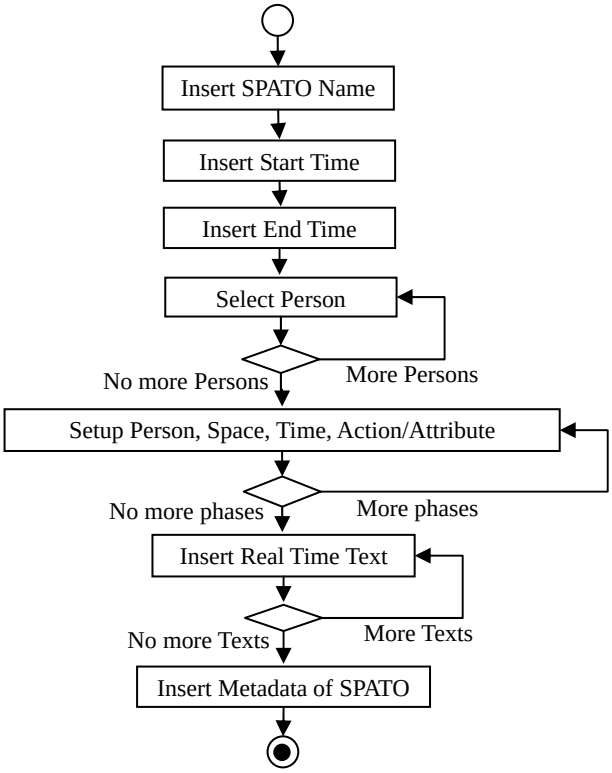

Figure 6: The Flowchart of Creating SPATO

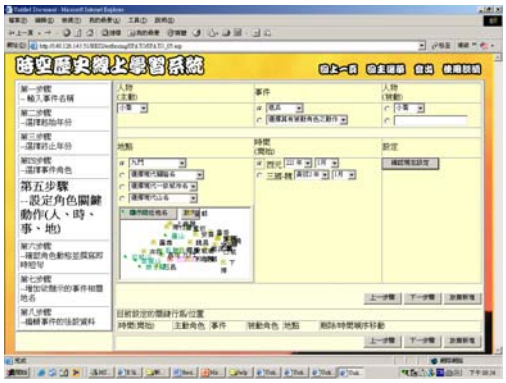

Figure 7: A Sketch of Authoring Interface for Creating SPATO (Setup Person, Space, Time, Action/Attribute)

3.3 SCO Authoring

A SCO is a collection of assets that becomes an independent, defined piece of learning material. The associated “Space”, “Person”, and “Action/Attribute” assets, stored in the Asset Pool, are integrated into SPATO to form a history SCO. No matter how many assets are included in a SCO, courseware designers only interest in how to display related asset at the same time. The flowchart for SCOs authoring is illustrated in Figure 8. Designers edit metadata of an SCO first. They then select one or more SPATOs for this SCO. After selecting SPATOs, corresponding text, image, audio, and Web page assets are selected accordingly to form an integrated history SCO.

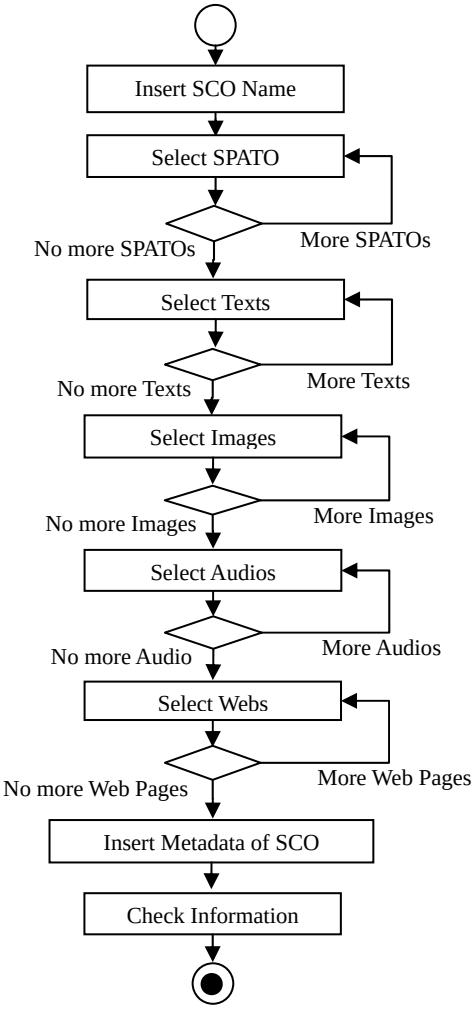

Figure 8: The Flowchart for SCO Authoring

3.4 Lesson Authoring

A lesson Base is a combination of SCOs. It may include one or more SCOs. Courseware designers create a lesson by selecting and organizing SCOs in the SCO Base (Figure 9). If a lesson includes multiple SCOs, it implies that there exists some relationships among these SCOs and the courseware designer wants to present such relationships in the lesson.

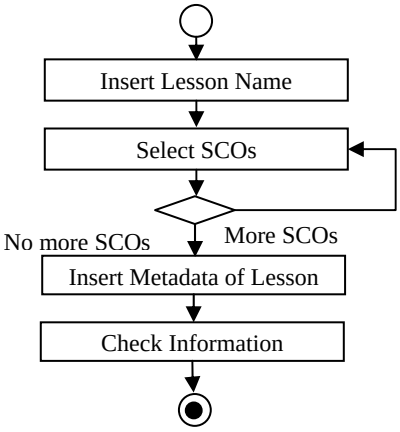

Figure 9: The Flowchart for Lesson Authoring

3.5 Course Authoring

A course is composed of lessons and sequential relationships among lessons. The sequential relationships are defined in Sequencing Constructor. In Sequencing Constructor, courseware designers define the relationships among lessons by sequencing objects (SO) which are provided by Sequencing Template. After defining the relationships among lessons, the layout of a course is defined in Manifest Transformer. After designing the layout of a course, HES-SPATO will translate the course structure into a Web file and store the file in Course Base. Courseware designers' first insert course name and abstract, then create courses by integrating SOs and lessons (Figure 10). Each node of SOs may be a lesson or another SOs. Courseware designers choose the content of each node by simply clicking and selection. SOs are the objects used to build up the course file structure. It's important that each SO should include lessons and there must be only one lesson at the end of a course. After inserting lesson files to SOs, the course is created.

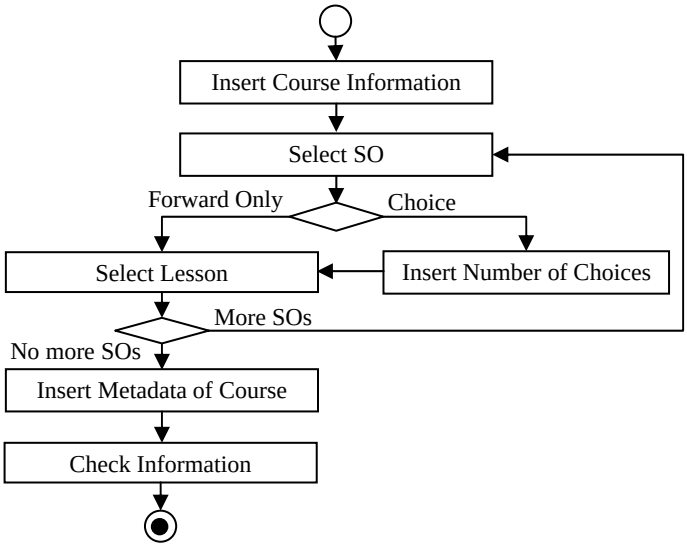

Figure 10: The Flowchart for Course Authoring

4. Learning Module

Figure 11 illustrates the learning module of HES-SPATO. With this module, students can view courses with integrated person, space, and time with low cognitive load and high understandability of learning materials. The student interface module contains ten features, which include Main Frame, Supplementary Data, Time Line, Event Title, Person, Real-time Information, Map View Controller, Animation Controller, Place Name Display Controller, and Information Layer Controller. In what follows, each feature is presented in detail.

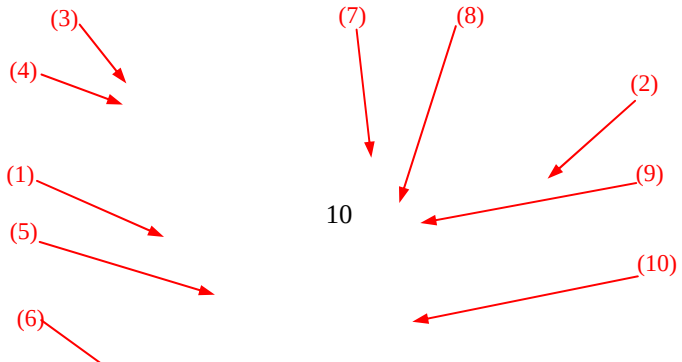

Fig. 11: Illustration of HES-SPATO learning module

(1) Main frame: It presents a lesson which includes history SCOs (integrated by SPATO and person, space, action/attribute assets). By applying the temporal logic proposed by Allen (1983) to reason the temporal relationships between history events, HES-SPATO can present history events in sequences with animation, hence, make the learning materials more understandable. HES-SPATO also integrates the person, spatial and temporal information of history events for increasing the understandability of learning materials.

(2) Supplement data: All related supplement data is showed on this frame. Learners can freely select different types of supplement materials.

(3) Time line: presenting the time defined in SPATO of history events.

(4) Event title: presenting the name of the current history event.

(5) Person: participants of the history events.

(6) Real-time information: a short sentence used to point out the key content of the animation of a history event.

(7) Map view controller: Learner can view any part of the map by using zooming and panning tools.

(8) Animation controller: With SPATOs, SCOs can present the dynamics of history events in sequences with animation. Students may pause or repeat the animation. They may let the system show the animation automatically or show the animation step by step by themselves.

(9) Space name display controller: Course designers define the related places to be presented in SPATO. Using the Place Name Display Controller of HES-SPATO, students can freely switch between displaying all place names in a given area or displaying only the place names directly related to the history event (see Figure 12 and Figure 13). As Figure 12 depicts, the system only presents the related information to the students. We believe that this feature is helpful to reduce students' cognitive overload.

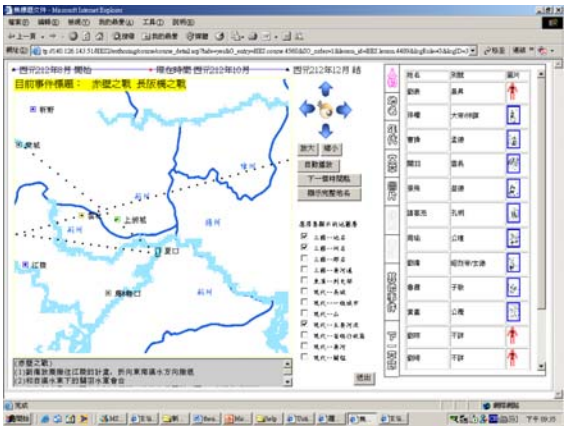

Figure 12: Map layers only display space information directly related to the history event

Figure 13: Map layers display all space information in the same area

(10) Map layer controller: Students can choose features, displayed with different layer, as they want. For instance, a student may choose to display three features, background maps, mountain and river, as well as city or display two features only, background map as well as mountain and river.

5. Conclusions

During the three years, the architecture, authoring module, and learning module were developed. In HES-SPATO, history SCOs were formed by integrating SPATOs with the associated “Space”, “Person”, and “Action/Attribute” assets, stored in the Asset Pool. SCOs, then, formed other SCORM components such as lessons and courses accordingly. Since not all course designers and instructors are skilled at information technology, so that they are limited in creating electronic history learning materials in most cases. The authoring module of HES-SPATO, which is designed to be used by courseware designers and instructors, was developed. With this authoring module, HES-SPATO can enhance the history courseware designer and instructor’s ability for creating online materials in a few guided steps with flexibility. The learning module was developed by applying the temporal logic and the GIS concept of information layers. With

application of the temporal logic to reason the temporal relationships between history events, HES-SPATO makes it possible to present history events in sequences with animation to clearly illustrate the dynamics of history events. With the learning interface, students can select features, displayed with different layer, to realize history events more clearly, in the manner they want, zoom in to see features at closer range, view variety supplement learning materials at the same time, and view SCOs according to his own progress and steps. Also, the interface can only display space information directly related to the history event, as defined in SPATO, to reduce the problem of cognitive overload. The findings of the experiments indicated that the use of HES-SPATO was effective in enhancing students' history learning. The participants also showed positive attitudes toward the HES-SPATO system in terms of the perceived ease of use, perceived usefulness, attitude to use, intention to use, recall of web sites, and perceived usefulness of assistant tools. Although many functionalities have been added to the HES-SPATO system, there was no significant difference in system efficiency between HES-SPATO and the comparative system.

6. Published Papers

So far, two journal and three international conference papers have been published for this project:

1. Lo, J.-J., Chang, C.-J., Tu, H.-H., and Yeh, S.-W., 2009, Applying GIS to Develop a Web-Based Spatial-Person-Temporal History Educational System, *Computers & Education*, Vol. 53, No. 1, pp. 155-168. (SSCI)
2. Lo, J.-J., Chang, C.-J., Tu, H.-H., and Yeh, S.-W., 2009, HES-SPATO: An Online History Educational System Based on SCORM, *Transaction on Edutainment* II (LNCS 5660), pp. 160-175. (EI).
3. Lo, J.-J., Chang, C.-J., Tu, H.-H., and Yeh, S.-W., 2008, 9/22-9/24, Developing a Web-Based History Educational System, *Cyberworlds 2008*, Hangzhou, China, pp. 71-77. (EI)
4. Lo, J.-J., Chang, C.-J., Tu, H.-H., and Yeh, S.-W., 2007, 9/15-9/17, A Spatial-Person-Temporal Online History Educational System, *7th WSEAS International Conference on Distance Learning and Web Engineering (DIWEB '07)*, Beijing, China, pp. 358-363. (EI)
5. Lo, J.-J., Chang, C.-J., and Yeh, S.-W., 2006, 6/25-6/30, A SCORM-Based History Educational System, *ED-MEDIA 2006*, Orlando, Florida, USA, pp. 949-954.

Other than the published papers, working papers will be submitted to well-known e-learning related SSCI international journal and international conferences.

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