A Design of the Digital Content Platform for Neurosurgery Education

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Abstract

Domestic medical digital contents begin to be extensive at present in Taiwan. Most of the digital contents are those medical/health information presented in the Internet. Their purposes are to promote the general population's health by providing health information. Little attention has been given to the development of digital contents for healthcare professionals. This study designed and developed a digital contents platform for healthcare professionals such as medical doctors and medical students. This platform integrates Neurosurgery multimedia education materials, which include texts, pictures, audio, video, and interactive quiz. Besides the front end of this platform, we also designed the back end to incorporate all kinds of data files, which will allow the back end users to insert, update and delete data files easily. Moreover, the users can also use this proposed platform to change one topic to another easily.

Key words: digital content, medical education, neurosurgery, educating CD-ROM, educating platform, multimedia, XML

1. Background and Motivation:

The Internet and information technology have changed people's lives greatly, and their influences are very broad, which includes the daily lives, education, communication, commerce…etc. People search information around the world without time and space constraints, which also inspires the practice of e-learning. E-learning has become a very important field and attracted many researchers to get involved. Information technology is considered to be a weapon to win the national competitiveness in this so called "knowledge economy" or "digital economy" era. The trend of globalization also leads to an even more severe competition among companies. To meet the challenge of the global economic, the Council for Economic Planning and Development (CEPD) of Taiwan government has promoted a plan called "Challenge 2008: National Development Plan" since May 2002. Among them, the most noticeable one is called "Two Trillion Double Stars Facilitation Plan" [1]. "Two Trillion" means that the output values for the semiconductor and LCD surmount will be one trillion new Taiwan dollars each and "Double Stars" means that both "biotechnology" and "digital contents" industries will be the two stars of Taiwan's industry. Digital content industry, which is based on Taiwan's strong electronics industry, can add values to the amusement industry, education, healthcare and publishing industry. Therefore, it is considered to be the model industry for Taiwan in the knowledge economic era.

According to report of III (Institute for Information Industry), the main investments of digital content industry of Taiwan is game software and web serves in recent years; the development in educational software

increases gradually too [5]. Given the overall trend in software industry, the software for medical fields is comparatively less. Most of the medical contents in the Internet are healthcare/medical information for the general populations. The digital contents for healthcare professional are few due to many reasons such as the production efforts are huge for MDs, the medical/healthcare professionals didn't have IT training, and the IT people didn't have medical/healthcare background. Therefore, compare to other software, the digital contents for healthcare professional is still scarce so far in Taiwan.

In the traditional medical education, lecture in the classroom is the most common ways for medical students to learn. Besides, the other activities include conducting experiment, operation and observation. Most of these skills need to be taught face-to-face by professors in a given time and space. This has limited both the professor's and the student's flexibility. For example, if the student didn't pay attention to one step of an operation, he/she won't be able to observe the step again. On the contrary, the student can repeat the unclear steps again and again until he/she totally understands when the operation process was filmed.

The digitization teaching material is different from the traditional medical textbook. Digital contents can be not only highly interactive but also abundant and diversified. Given the abundance of multi-media, many kinds of educational materials such as e-book, video, audio, animation, PowerPoint file, text can be integrated together. The advantages to use interactive multi-media are as follows: 1. Students can control their own paces of learning, including topics and time span. 2. Interactive multi-media are more interesting than traditional medical textbooks. 3. The learning process can be recorded and analyzed. 4. The students can get immediate feedback from the interactive multi-media.

Because the medical education knowledge belongs to a more specialized domain, not only the specialized content obtains not easily, also these medical knowledge need to be organized and verified by the professor or experts. Moreover, to share this systematic knowledge to the students conveniently is another important issue. Based on above reasons, we designed a "Dynamic digital contents production platform". It allows the users to design system's user interfaces according to their preferences. The users can also determine the digital contents to be put into the system. Most importantly, the specialized medicine knowledge can be automatically integrated together, and output to an educational CD (Compact Disk). The medical college students or intern can learn better by voluntary exploring of the medical digital contents.

2. Literature Review

2.1 Application of interactive multimedia educating

In the past, students are often given lessons through the class by matching the reading of the textbook. But already there are a large amount of interactive multimedia educating materials used and issued in recent years. It revealed the importance of adoption of interactive multimedia educational materials. Parvati Dev (1999) found in anatomy teaching, involving large amount of movies and computer pictures, the problem of chaotic and complex pages due to mixed images and surrounding texts can be solved by utilizing the digitalized dissection diagrams collections. Moreover, by penetrating the 3D images, it may help the students understand how human body grows effectively. The digitalized medical image and video teaching materials not only vivify the medical education, but also enable the presentation and discussion of medical records [8].

Besides the traditional classroom teaching method,

developing CD-ROM is another effective method for the students to get information. To overcome the constraints of teaching resources, Scholten et al. (2000) developed an interactive multimedia CD-ROM to promote students' learning of the detailed mechanism of swallowing, and provided a learning resource to strengthen students' understanding about the linkage of the internal functions of abnormal swallowing and the external signal. Traditional textual interface and graphical interface can't express the swallowing procedure vividly, however, a simulation effect of swallowing can be generated by displaying the whole process dynamically and streaming audio and video. Its goal is to utilize the visualization module to help students to understand the process of swallowing. The whole module was set up on the multimedia platform, offering users various methods to explore the entire swallowing course through interactive way. When compared with the traditional way, it improved the students' learning effect greatly [9].

Dragone et al. (2002) used the interactive CD-ROM to carry on the health education for 4-11 years old children with leukemia and their families [3]. Stromberg et al. (2002) developed an interactive multimedia education CD-ROM for heart failure patients. The system supports many languages, and the content includes animation, picture and audio [10]. Jha et al. (2002) developed an interactive computer–assisted learning program for the students of the medical college, it combined films, diagrams, 3D images, interactive anatomy, and self- assessment of the multiple-choice questions, and the learning effects were very good [4].

Ortega et al. (2003) created a computer system to support CRL (Clinical Reasoning Learning), which includes e-book, case study, medical images, policy guidelines, etc. The system displays the cases by a progressive manner that students obtained information by asking questions. The whole course can improve students' thinking and inquiring tactics. Utilizing the coordination environment of the multimedia clinical research with the CRL, the system components included communication tool, materials of the multimedia, information sharing and electronic note, electronic white board, etc. Using the distance-learning manner to reach the goal of the interactive learning and integration of the electronic resources, the system had improved the original effects of CRL [7].

Lison et al. (2004) developed the concept of "virtual learning" and discussed how to apply virtual study to medical training and education. The development process of virtual learning involves multiple disciplines including medical science, medical informatics, computer engineering, and education. Their purpose was to develop an open intelligent web-based system for medical education and to improve the acceptance of students and the efficiency of learning [6].

From the above literatures, we conclude the up going trend of interactive multimedia medical education. This study we designed a platform incorporating many kinds of multimedia and offering an interactive learning environment for medical students or interns.

2.2 XML Tag Subscribe Mechanism

XML (Extensible Markup Language) was a kind of labeling language, which announced formally by W3C organization (World Wide Web Consortium) in February, 1998. XML is simplified from SGML (Standard Generalized Markup Language) and its goal is to enable generic SGML to be served, received, and processed on the Web in the way that is now possible with HTML. XML has been designed for ease of implementation and for interoperability with both SGML and HTML [11].

XML is a simple and intuitive data form, and has the following characteristics:

- Self-meta capability
- Separating document content and document display
- Uncomplicated and easy to write
- Open standard
- Extensible
- Convenient to compare, search and collect data

We used XML to describe and define the documentation files in our system. The meaning of their contents can be directly read from the name of the tag.

3. System Architecture

3.1 Concept

The architecture we designed need to transfer the content in system into the compact disc dynamically; therefore, the entire architecture is composed of two tiers -- *front-end tier* and *back-end tier*. The back-end tier is to let user input digital contents, produce file structure and application program (Disc file). The front-end tier is where users can begin to explore the system. After the user inputs all of content files from back-end tier, the content generator module then produces execution programs, setup programs and associated files that will be used in the front-end tier automatically, which is called *dynamic content generator*. The user enter the content files from the back-end, then the dynamic content generator integrates all the content files and produces the files for digital content discs. The total number of discs may be more than one, according to the amount of contents. In this way, experts only need to prepare their own contents, and this dynamic content generator will allow them to share their knowledge easily.

3.2 Workflow of Digital Content Generation

The workflow of digital content generation is shown in Figure 1. The final output disc's structure and the way it will display are determined from this process. In other words, dynamic content generator is the kernel of entire workflow of digital content generation. User prepares the contents to be entered into the system, and the generator will produce three types of files in project folders: 1). the input files including document files, video files and picture files. 2). XML document files. 3). Executable application programs. Three types of files were aggregated into specified directory and output source files for digital content disc. We explain the details as follows:

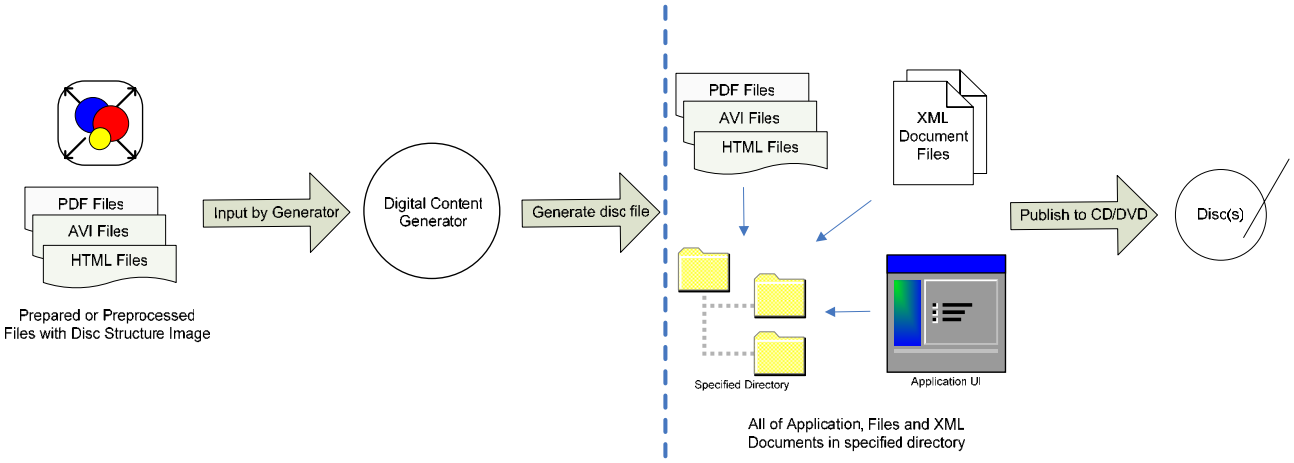


Figure 1. Workflow of Digital Content Generation

- **Input teaching material files:** User input the teaching material files (e.g. electronic text document, picture, and video). When needed, generator will modify the file name only and won't modify file content.
- **XML document files:** XML document files are produced by generator to record the information such as the structure of directory, the description and keyword of each teaching material files. The design of XML Schema needs to describe all of directory structure in each function, interface style and file description.
- **Application user interface:** Application user interface is generated by generator let the back-end users design the front-end interface a certain appearance and the ways delivering the teaching material files to front end users.

Generator assigns each files to specified directory. Application program will read XML description to know where to load specified file from which directory, where to read the other XML file, and where to execute the application user interface.

3.2.1 Prepare and Preprocess Files

To construct a medical digital content disc, users need to plan the structure of entire disc first and prepare digital content to be put in. All types of files need to be preprocessed.

The files of teaching materials came from different types of format, including electronic document, picture, video, and quiz files:

- **Electronic document files:** Teaching materials or paper documents without electronic format need to be scanned into picture files and converted into e-book. One electronic file may be separated or joined with the other file, according to the knowledge map. To avoid the complexity of different electronic formats, we convert all electronic files into portable document format (PDF file).
- **Picture file:** Both the resolution and size of picture files are two important issue when those medical picture files need to be displayed at the front-end tier.
- **Video file:** Medical content providers always record the videos of surgical operation in DVD format, which provides clear vision but generates huge files. Surgical operation often takes as long as two hours, but the critical part of videos takes only ten to twenty minutes or even less. To make the size smaller and the time duration shorter, we used specified software (e.g. DVDX, Windows Movie Maker) to compress (by codec DIVX or XVID) the video into AVI file, which size is very small and can be cut into smaller pieces before feeding into the generator.
- **Teaching material file:** The sources of medical teaching materials came from medical doctors or professors. When the content providers give lecture in the classroom, some of the commercial software such as StreamAuthor® can record the voice, video of presenters as well as the content of presentation at the same time. The generated files can be easily incorporated into our platform.

- **Quiz:** Users may give themselves tests in the middle or end of learning. Questions may contain description, pictures and even animation, depends on how the content providers design this quiz.

The content can be searched both by the menu driven and keyword search. For the menu driven part, each part is labeled and indexed. According to the knowledge map, the parent and child nodes can be either topics or functions. In figure 2(a), the parent nodes are topics and the child nodes are functions. In figure 2(b), the parent nodes are functions and the child nodes are topics. The content providers can design their own structure of contents. For the keyword search part, the related materials as well as their knowledge maps will be displayed once the keyword is typed in.

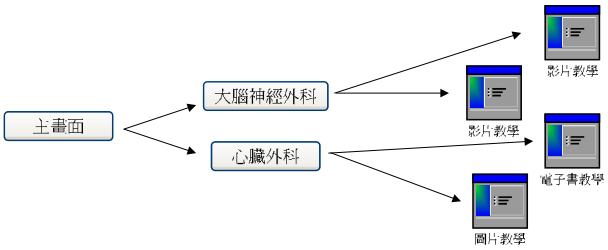


Figure 2(a). Menu driven tree structure I

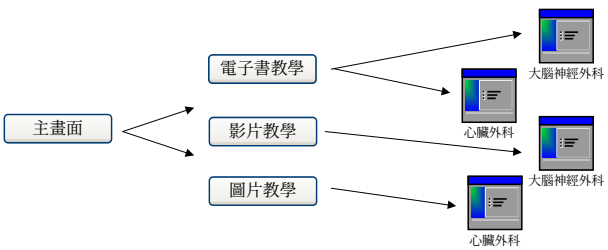


Figure 2(b). Menu driven tree structure II

3.2.2 Style of User Interface

To design a rich and attractive medical digital content, user interface is important. Different domain of expertise has its own style of design concept. Just like Theme Pack or Skin Pack, generator provide default theme, include background, button color etc. We also describe font, font style, and color of button motion using XML, just like Cascading Style Sheets (CSS) in web page [2]. The style of web page will change automatically once the CSS file is changed.

3.2.3 Publish

Generator put the disc file in one project folder. After input files from back-end tier, user can preview the disc and modify if needed. At last, user burns all files of project folder to the disc. Disc file contains the necessary files, such as program runtime environment (.NET Framework 1.1) and Adobe Acrobat Reader, etc.

4. Workflow and Function

4.1 Disc Structure

We design a tree structure to display all the contents as Figure 3(a). The contents can be organized as a combination of *Menu Structure* and *Functional Module* as Figure 3(b).

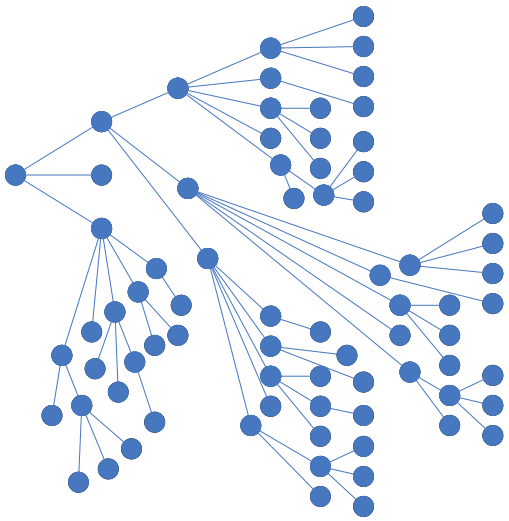


Figure 3(a). An instance of disc structure

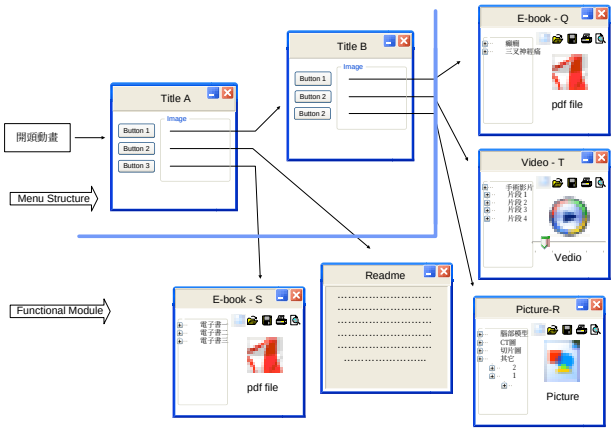
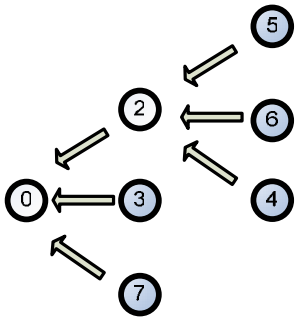


Figure 3(b). Top-Left side is Menu Structure, right side and bottom is Functional Module.

As shown in Figure 3(b), the top-left side is Menu Structure, the right side and bottom side is Functional Module. Basically, all contents can be a part of tree structure, which combines menu structure and functional module. One functional Module can place in different node, such as e-book-Q and e-book-S in Figure 3 (b). Each module displays as *Tree View*. Root-node of tree view connects to last layer node of menu. The tree structure can also be regarded as the *Knowledge Map* of the whole contents. Menu structure and functional module are explained more detailed as follows:

- **Menu Structure:** Back-end tier allows the user to input menu structure, and to convert it into tree structure format (Figure 4). Figure 5 shows the XML for the node 0 and node 2 in figure 4. Background, picture, text description and related information are stored in the paragraph between <node> and </node>. When the user adds an item in menu structure, a new paragraph of XML will be added.



** Number represents the No. of node. Blue circle is a functional module.*

Figure 4.Tree structure of disc

```
- <disc_structure>
  - <node>
      <no>0</no>
      <parent>-1</parent>
      <title>Title A</title>
    </node>
  - <node>
      <no>2</no>
      <parent>0</parent>
      <title>Title B</title>
    </node>
</disc_structure>
```

** Node 0 is a root node, parent denote to -1 (NULL), node 2 is a child of node 0. <title></title> describe node title.*

Figure 5. XML Describe node 0 and node 2

- Functional Module: Functional Module is the place to let users define each file's function and the way it should be presented (Figure 6). In functional module, each time user input one file and its corresponding information including file name, location, file format, keywords, description, node number, parent node and title. After that, a paragraph of XML will be generated automatically (Figure 7). The users will be able to see the results like Figure 8, 9, 10 and 11 from the front-ends.

Figure 6. Functional module's input interface

```
<?xml version="1.0" standalone="yes"?>
<DataSet>
<xs:schema id="NewDataSet" xmlns="" xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns:msdata="urn:schemas-microsoft-com:xml-msdata">
  <xs:element name="NewDataSet" msdata:IsDataSet="true" msdata:Locale="zh-TW">
    <xs:complexType>
      <xs:choice maxOccurs="unbounded">
        <xs:element name="record">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="no" msdata:AutoIncrement="true" type="xs:int" />
              <xs:element name="parent" type="xs:int" minOccurs="0" />
              <xs:element name="title" type="xs:string" minOccurs="0" />
              <xs:element name="img" type="xs:int" minOccurs="0" />
              <xs:element name="file" type="xs:string" minOccurs="0" />
              <xs:element name="ext" type="xs:string" minOccurs="0" />
              <xs:element name="size" type="xs:string" minOccurs="0" />
              <xs:element name="location" type="xs:string" minOccurs="0" />
              <xs:element name="keyword" type="xs:string" minOccurs="0" />
              <xs:element name="description" type="xs:string" minOccurs="0" />
              <xs:element name="modified" type="xs:string" minOccurs="0" />
```

Figure 7. Functional module in XML

4.2 Front-end Tier

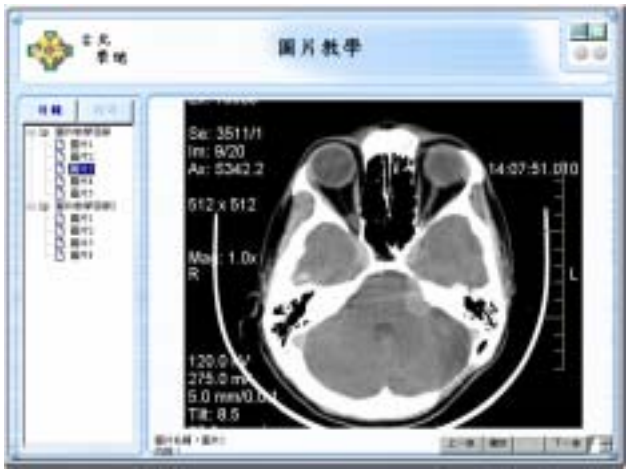
From the view of front-end tier, each time the user execute the program, system will read specified XML, loads the needed files and display the tree view of menu. In this study, Neurosurgery Neurological Institute of Taipei Veterans General Hospital provided all medical contents. Those medical contents were classified into five types: e-book, picture, video, virtual class and quiz.

- **E-book:** To be consistent, the e-book is presented in PDF format. The PDF browser is embedded in the program and will be opened automatically once a PDF file is opened. The screen of e-book is shown in Figure 8.

*Picture Source: Yang-Hsin Shih M.D. et al.

Figure 8. Left side is tree view structure, right side is e-book displaying PDF file

- **Picture:** Medical teaching materials always include many picture documents such as X-ray, CT graphic, MRI for students to reference and learn to make judgment and decision. Our system allows the users to browse pictures one by one or to display all pictures automatically. The screen of picture is shown in Figure 9. The system also can display two or more pictures together, and it also allows the users to take note or to mark up details on the picture.



*source: http://sprojects.mmi.mcgill.ca/braintumor/

Figure 9. Left side is tree view structure, right side is picture.

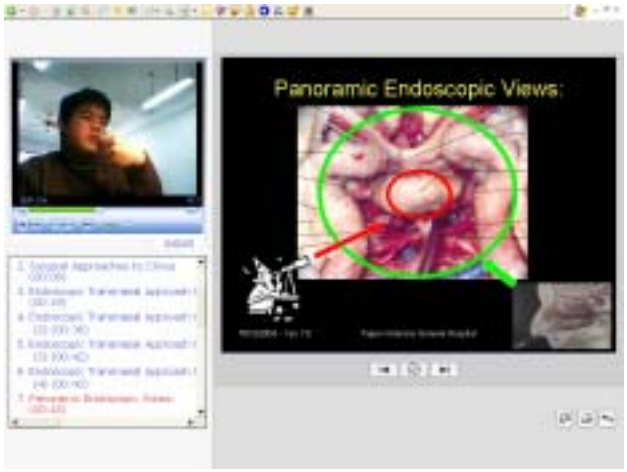
- **Video Play:** For those operation videos, our

system embedded Windows Media Player® 2 (Classical) in. It has all function of Windows Media Player®, include full screen play. The screen of video play is shown in Figure 10.

*picture source: Min-Hsiung Chen M.D.

Figure 10. Left side is tree view structure, right side is video playing.

- **Virtual Classroom**: When medical doctors or professors give lectures in the classroom, some of the commercial software such as StreamAuthor® can record the voice, video of presenters as well as the content of presentation at the same time. The screen of incorporating virtual classroom materials is shown in Figure 11.



*Picture source: Yu-shu Yen M.D. et al.

Figure 11. Virtual Classroom

- **Quiz:** The system will give interactive quiz executed by Flash. The questions are selected randomly from XML files. The screen of quiz is shown in Figure 12.

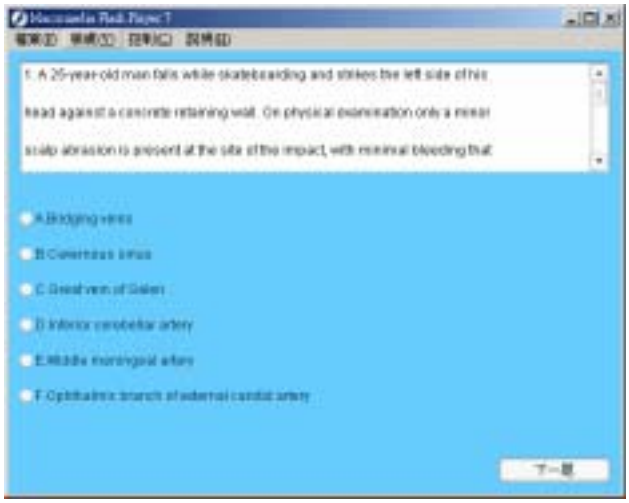


Figure 12. Display Quiz in Flash

In functional module, objects such as interface presentation, tree view and search function often duplicated. Consequently, the platform is designed with object oriented programming method. By constructing a unified superclass and let each functional module to be subclass, which can has its own attributes and functions. In this way, when constructing a new functional module is needed, it will be quick and easy.

5. Conclusions and Discussion

The prototype of this digital content platform aims to incorporate the important medical teaching materials of one department. By setting knowledge map, we can produce a multimedia educating CD-ROM. Now we continue carrying on the research efforts of better artistic design and better function design in next edition. Most importantly, the digital content will meet the medical professional's teaching and learning needs.

The other goal of this study is to construct a

dynamic digital content generator, which can be used in any fields to generate multimedia educating CD-ROM. For the needs of different field, as long as the knowledge maps and content files are provided, the generator can finish a set of intact educating CD-ROM in no time.

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