



A MULTIPLATFORM CONTENT MANAGEMENT SYSTEM FOR CURATORS TO PROVIDE TEACHING MATERIALS IN ASTRONOMY EDUCATION

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ABSTRACT

Since it is difficult for curators who are not information field specialists to provide teaching materials on the Internet, we built a content management system to support the delivery of teaching materials on the Internet. Specifically, our system, which allows correspondence between various platforms, considers the distribution method of teaching materials in cooperation with an actual planetarium program. As a result, curators effectively utilized the Internet and distributed teaching materials. To clarify the usefulness of this research, the curators of the Nagoya City Science Museum used and evaluated the system.

Keywords: *Multiplatform, Content Management System, LAMP, Open Source, Podcast, Online Teaching Materials, Planetarium, Constellation Observation*

1. INTRODUCTION

Planetarium curators believe that the most important element in astronomy education is observing real stars outdoors. For that purpose, virtual experience in a planetarium serves as important positioning. Learners hear stories about how to find the stars and interesting topics in planetariums. They gaze at the stars in the actual night sky based on these stories. This is the ideal situation dreamed of by curators. Therefore, curators practice various kinds of astronomy education for beginners at planetariums. For example, they might explain how to find a constellation that is currently visible. However, visitors have difficulty remembering how to find the constellation when they return to their homes. Therefore, curators want to offer teaching materials that can support outdoor study when they are unavailable. There are many web sites for stars and astronomy education, but student learning environments often require PCs. To achieve education that reflects the curator ideal, the following requirements must be provided:

- 1) Contents that can be carried outdoors to see the actual starry sky
- 2) Contents that cooperate with the actual planetarium program

Contents distribution by Podcast is expected in astronomy education [1][2], and teaching materials with higher educational effect can be offered using a variety of information technologies [3]. However, it is difficult for curators who are not information field specialists to offer teaching materials with a new technology. If contents linked to actual planetarium programs are offered, they can be used as preparation and review of a planetarium, but creating contents matched by curators to various terminal devices is time-consuming. Therefore it is difficult for busy curators to offer contents linked to an actual planetarium program.

Methods to manage educational contents include the research of the Learning Management System (LMS), the Course Management System (CMS). Impey, C. D. who managed the astronomical teaching materials used at a university lecture and built a synthetically offered system [4]. However, course management for university lectures differs from content management that realizes an educational method sought by curators. For content management by curators, Kenro researched a method to manage museum exhibits [5], but this research is designed for digital archives about exhibits. Since the teaching materials for astronomical education not only contain the exhibit



but also contents that constantly change, this method is not suitable for astronomical teaching materials.

In this research, we built a system through which curators can efficiently distribute teaching materials for astronomical education by utilizing information technology. So that teaching material contents can be easily used outdoors, we provided the contents to mobile terminal devices such as cellular phones, portable media players, and portable game machines, etc. We also developed a distribution method for the contents that cooperated with the planetarium.

We built a content management system that enables teaching-materials distribution to a multiplatform. As a result, curators can offer teaching materials effectively for students who observe constellations outdoors after returning home. Users can also study to deepen their understanding of astronomy. The curators of the Nagoya City Science Museum used the system and evaluated it to clarify its effectiveness.

2. TEACHING MATERIALS PROVISION OF CONSTELLATION OBSERVATION

Even if many people can access teaching materials provided online, it is difficult for curators who are not information field specialists to realize them. Currently various digital teaching materials are used in astronomical education, for example, a portable tool that supports constellation observation that can be used outside. However, since curators cannot show suitable information timely, they are insufficient for astronomical education.

2.1 Digital Teaching Materials in Astronomical Education

In astronomical education, various digital teaching materials are available, such as information provided by website and a portable tool that can be carried outdoors, etc. For example, cellular phones offer an application that utilizes a motion control sensor and supports constellation observation [6]. For portable game machines, the sky navigator software "HOMESTAR PORTABLE" is available [7]. Moreover, a hand-held device called "SkyScout" has also been developed that identifies star positions and names [8].

However, many of these digital teaching materials are not in complete agreement with the

educational method sought by curators. Since astronomical information often changes by the season or time, the contents that curators want to teach also change. Therefore, curators must provide learners with suitable information that reflects the season. Curators need a mechanism that can effectively provide astronomical teaching materials online.

2.2 Teaching Materials Required in Astronomical Education

In astronomy education, the most important element is seeing real stars outdoors. To enable teaching materials to be used outdoors, portable terminal devices must be offered. Such devices must correspond to various learning environments. Moreover, to offer teaching materials that cooperate with the actual planetarium program, the contents must also be reorganized. Thus, so that various terminal devices correspond, and to offer information that cooperates with the actual planetarium program, curators need much time and effort.

2.2.1 Teaching Materials Based on Various Learning Environments and Terminals

In many web sites about stars and astronomy education, learners must often study by PC. However, since they must engage with the actual night sky to gain such natural experiences, they need to carry the contents outdoors. By corresponding to the following platforms, required astronomical information can be carried and easily learned outdoors any time (Figure 1):

- (1) PCs
- (2) Cellular phones
- (3) Portable media players (Support Podcasting)
- (4) Portable game machines

In Japan, the diffusion rate of cellular phones is over 75% [9]. Many models can browse Internet sites and play video. In astronomical education, correspondence to cellular phones is an effective means of teaching-materials distribution from the diffusion rate side and from the portable side. Podcasts are suitable for outdoor study, because the video contents that support constellation observation can be easily forwarded from the PC to the portable media player; they can also be carried. If they correspond to a portable game player, teaching materials can be offered to a child. Thus,

might be neglected, which might cause problems. A mechanism must be built to offer information without relying on the time and effort of curators.

However, correspondence formats vary across platforms. For example, different kinds of video files must be provided based on different terminal devices. Since the screen size setup or resolution also changes with terminal devices, various video formats are also needed. Curators need to make constellation information efficiently correspond to a multiplatform without applying much time or effort.

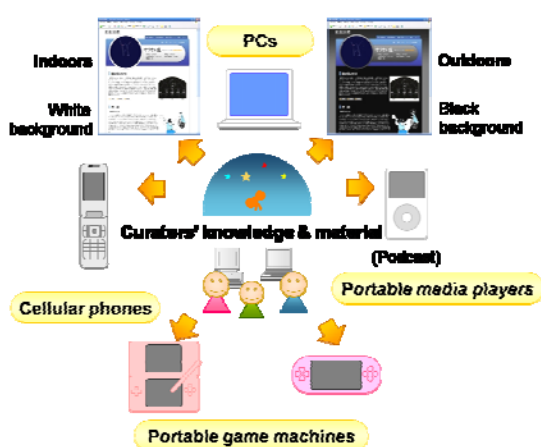


Figure 1. Learning materials provide various environments and terminals

2.2.2 Planetarium Collaboration

Even excellent contents that utilize curator knowledge will not be used effectively if the distribution method is difficult. Visitors can use them for review at home by going to the website of information curators introduced at the planetarium, including related information on other websites, blogs written by curators as educational activities, and slides used during planetarium explanations. Users who look at planetarium information by website can visit a planetarium and deepen their understanding of astronomy. Moreover, users can review things learned at the planetarium using websites at home. Thus, information must be offered that cooperates with the planetarium.

However, even if information services by websites are effective, busy curators cannot spend much time on them because contents must be reorganized for the Web. When curators spare time for such work, everyday educational activities

3. MULTIPLATFORM CONTENT MANAGEMENT SYSTEM

We built a framework that enables the generation of contents that correspond to a multiplatform to broadly offer contents that utilize curators' knowledge. By building a framework on a server, contents can be generated through a network. However, since the operation is difficult for people without server knowledge, we built a content management system that can be easily operated by the Web as a framework interface.

3.1 System Framework

There are 88 constellations in the sky. Because such constellation information corresponds to the seasons and times that change frequently, contents must always be displayed in identical conditions in all platforms. Therefore, contents must cope with different terminal devices that effectively support multiplatform terminals. For example, dynamic page display was achieved on each platform by extracting data and data style.

Then the constellation information's contents resource, data format, and web design are managed separately based on one database. Moreover, PHP is used due to its suitability for the dynamic web. With it, the information in the database is processed based on the learner's demand, so the web site can be built dynamically. A website suitable for a device is automatically displayed using the identification information included in the acquisition demand from a browser.

We built a general-purpose system based on a Linux, Apache, MySQL, and PHP (LAMP) environment and open-source software (Figure 2).

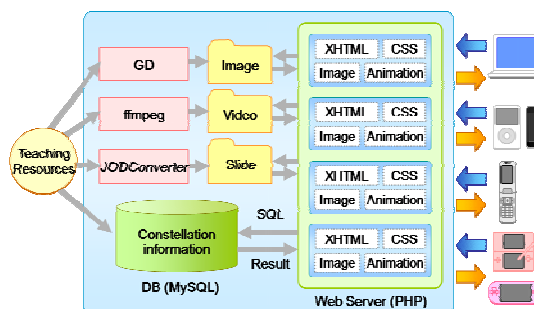


Figure 2. Framework for multiplatform contents generation

3.1.1 Constellation Database

This system corresponds to PCs, cellular phones, portable media players, and portable game machines. Even using identical text information, it must be prepared based on the platform's format. But, this is inefficient when treating astronomical information that needs frequent updates. To efficiently correspond to a multiplatform, all the constellation information to treat is managed in the database. As a result, because it was possible to manage by separating constellation information and the format of each platform, correspondence to an efficient multiplatform was realized.

When learners access the web site through a different platform, the PHP connects to the database, and the information required (text, images, or videos) for the learning environment are extracted from the database and the related directories by PHP and SQL. Then it is offered in an appropriate format. Therefore, learners can use the teaching materials suitable for a learning environment without exploiting curators' time and effort.

3.1.2 File Conversion for Multiplatform

The teaching materials offered by curators mainly consist of text, images, and video. These materials must be offered so that they can be used from various platforms. However, since images and video have cases where the correspondence format changes with platforms, manual correspondence is time-consuming. When the screen size of the terminals is different even if the supporting format is the same, it must resize the image and video.

The material is uploaded online and the file is changed by the server so that curators can change and resize the format easily. Then we built a framework that utilized open source software to automatically generate contents suitable for each platform. Figure 3 shows a correspondence example of format conversion. The image enables resize matched to the screen resolution using GD and ImageMagic [11][12]. The video format is converted on the server side using FFmpeg, which is the video conversion application of open source; it can also be provided to an appropriate device [13]. The presentation slide file can also be

converted to a format that can be put on web sites using JODConverter, the document conversion tool of open source [14].

Format	Image			Animation (Video)					Slide		
Software	GD ImageMagick			FFmpeg					JOD Converter		
<div><div></div><div>File format & file size conversion</div><div></div></div>											
	gif	jpg	png	flv	wmv	mov	m4v	3gp	mp4	jpeg	swf
PC	●	●	●	●	●	●	●	●	●	●	●
iPod	●	●	●			●				●	
iPod touch	●	●	●			●	●			●	
Cell-phone	●	●	●					●		●	
PSP	●	●	●						●	●	
DS	●	●	●						●	●	

Figure 3. Correspondence example of format conversion

3.1.3 RSS Application

Constellation information change frequently based on the season or time. Therefore, it is important to frequently update information. However, it is difficult for curators to frequently update information except during regular work.

External RSS information is adopted for display as related contents. As a result, the related latest information can be easily shown to support overall study.

Moreover, original contents are offered by RSS based on the season. Since learners can receive new information automatically by RSS, seasonal astronomical information can be effectively offered.

3.2 Administration Tool

This system manages contents using a database so that it corresponds to a multiplatform. The file format is converted on the server side for multiplatform correspondence. The administration tool is also built for easy use from the web.

In this content management system, distant users access the web form and can easily manage and update data. For this system, the following functions were developed: data search, data addition, data update, and data deletion (Figure 4).

Materials such as images, video, and slides can also be similarly uploaded using the web form. All uploaded material from a web form is managed in the database and saved in an appropriate directory.

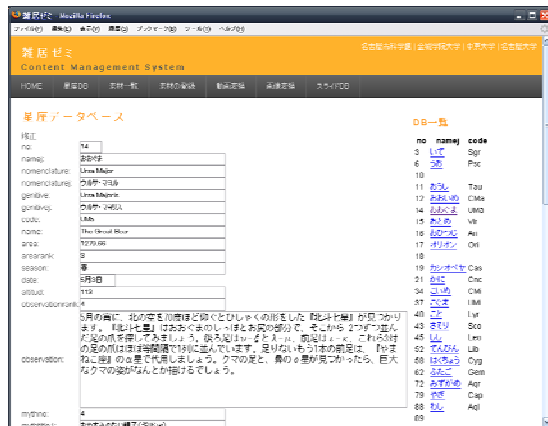


Figure 4. DB registration Web form

In this system, since the video format is changed on the server side, we created an interface that can easily change the format of the saved material. For example, when registering a video from the material registration form, the captured image and flash video are automatically generated so that the video contents to change can be checked. As shown in Figure 5, FlowPlayer, an open source FLV player, is used; the captured video image is displayed, and a video can be played [15]. The button for format conversion is displayed on the right side. When clicked, video corresponding to the terminals is automatically generated on the server side. In addition, this button's image changes to clarify whether it generated video corresponding to the device.

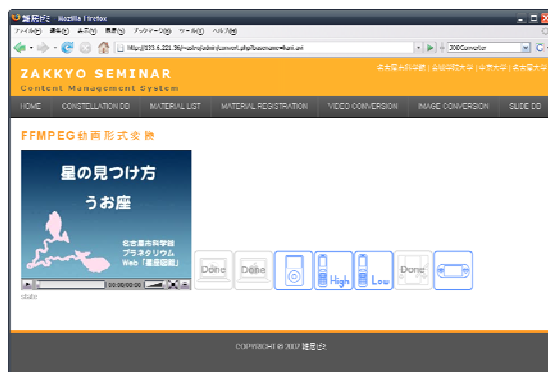


Figure 5. Format conversion of video

By using such an interface, even curators who are not information field specialists can manage the

teaching-materials contents without being conscious of multiplatform correspondence.

4. PRACTICAL APPLICATION BY CURATORS

The curators at the Nagoya City Science Museum offer various astronomical educations to beginners through such activities as the planetarium and an astronomy club. The members of the special planetarium education program gather to observe constellations and astronomical phenomena with curators. Offering educational know-how acquired from these practices in various forms is very worthy by utilizing a network. We created teaching materials called the "Online Constellation Cards" that harnessed curator knowledge and educational know-how in joint research with the Nagoya City Science Museum. It mainly teaches how to find identify constellations outdoors [16]. By utilizing the content management system for these teaching materials, we support the teaching materials offered by curators.

4.1 Providing Contents by Multiplatform

At the Nagoya City Science Museum, curators design programs and explain them in their own words and reflect their own personalities including seasonal features and so on. By exploiting this feature, we made contents using descriptions by curators (Figure 6) that explain how to find the constellation culminating at 8:00 p.m. This is based on stars that are easy to find in many cases, but difficult for beginners. Therefore, beginners can find the constellation based on an angle that can be measured using hands.

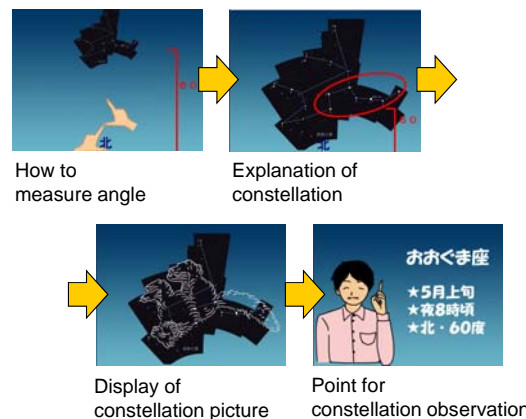


Figure 6. Video using curator explanation

Since seeing real stars in astronomical education is important, our system can use such contents outdoors. However, until now format conversion to each platform was performed manually, which is difficult and time-consuming. However, teaching materials were provided to various platforms using our content management system.

Figure 7 shows an example of a display corresponding to a multiplatform of a video that uses explanations from the curators of the Nagoya City Science Museum. As a result, teaching materials were produced that assumed carrying a device and learning outdoors. When learners look up at an actual sky, they can utilize the curators' knowledge.



Figure 7. Video contents for multiplatform

4.2 Information Relevant to Planetarium

If teaching materials with multiplatform correspondence can be offered in cooperation with an actual planetarium program, the educational value is enhanced.

The provisions of a web page integrated with a planetarium program were realized using databases and RSS feeds (Figure 8).

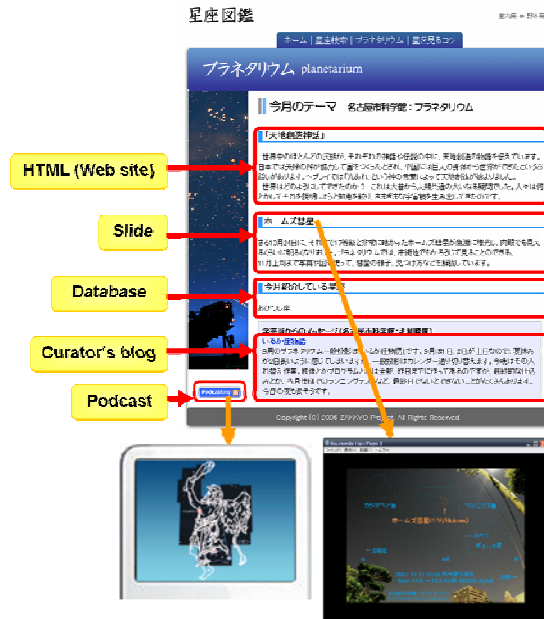


Figure 8. Web page with program of an actual planetarium

4.2.1 Planetarium Themes and Slides

The official web site of the Nagoya City Science Museum provides information about each month's planetarium theme. This information is used as contents. The information on a web page is constituted by HTML and the monthly theme is published by regular format. Using a regular expression, the monthly contents of a theme are extracted and an RSS is published so it can be reused by this system.

In addition, the system, automatically reflected in the web page, was also prepared by inputting the slides and explanations used by curators from the web. As a result, visitors can review what they learned from the curators at the planetarium programs.

4.2.2 Blog

Blog articles written by curators as part of educational activities were displayed on this page as "hot topics" by displaying the RSS. They can also be displayed by choosing only a specific category. On the planetarium page, just the latest planetarium information has been shown by displaying the information on the blog's planetarium category.



4.2.3 Podcast

The day when the constellation culminates at 8:00 p.m. is registered in the database. By utilizing this information, a portable media player can distribute the constellation information (video) in season by Podcast. In this case, the latest contents are usually distributed automatically, but this system generates XML (RSS2.0) for the Podcast by extracting monthly constellation information from the database.

As a result, season-appropriate teaching material can be delivered. Thus, the video contents of a constellation that culminates at 8:00 p.m. were distributed by Podcast.

5. DISCUSSION

Five curators of the Nagoya City Science Museum completed free description questionnaires to clarify its effectiveness. Their comments are classified by two items and summarized:

A. Multiplatform:

- Offering teaching materials corresponding to various formats has a fairly high hurdle for astronomical educators. It is necessary to lower the hurdle on the offer side as much as possible to use good contents widely. At this point, this system is simple and good.
- Storing information in a database in the same format offers flexibility for future new media. This is effective because it might attract more users and increase their interest. A future problem concerns what kind of media to correspond.
- It is good that users can choose which terminal device to use such as PCs, cellular phones, or iPods. In addition, the system is also so refined that optimized contents can be generated from one database.
- I think that this system, which can respond flexibly based on media trends, can effectively spread accurate knowledge about constellations and the stars.

With this system, teaching-materials distribution was completed for a multiplatform that was previously difficult for curators. It used to be

technically difficult, even though curators themselves wanted to distribute their technical knowledge. However, this system is useful for both curators and users because it can simply and widely distribute good contents.

Moreover, it is also effective from the viewpoint of teaching-materials distribution, not only to lessen curators' time and effort but for broader distribution of teaching materials in the future. Since contents can be generated from one source to other platforms, when a new platform appears, it can respond flexibly. So an environment can be prepared for distributing teaching materials.

B. Cooperation with planetarium:

- Planetarium cooperation is indispensable. It is important that learners get the best experience using various media and tools.
- I think it is effective because it can easily be confirmed by cellular phone or iPod, etc., when the person who saw the planetarium is going to actually look for the stars outdoors.
- When looking for a constellation, Beginners may not understand where and what constellation they want to look for. If the constellation contents of the culmination are distributed by Podcast every month, a constellation can be looked for only by always looking in the same direction. I think that is very comprehensible for beginners.
- Because the moon and planets move in a constellation, they cannot be introduced in the contents of a constellation. I think it is helpful to look for the stars in the actual sky because astronomical information on blogs can also offer such subjects.

Curators believe that offering contents for cooperation with actual planetarium programs is an effective teaching materials offer method for visitors. By gathering external information, for example, information on the planetarium theme from the web site in the science museum is obtained, the curators' daily educational activities are included in the contents, and various contents can be offered without taking time and effort.

Moreover, by utilizing Podcast, even if a user does not visit the website, she can automatically receive teaching materials. Since contents suitable for the characteristics of the terminals can be distributed with information on the planetarium



program, the education effect of the teaching materials can be heightened.

6. CONCLUSION

In this research, we built a content management system for teaching-materials distribution for a multiplatform. Contents that used curator technical knowledge could be offered to many platforms using this system. Moreover, curators themselves can provide information by building a system to utilize curators' everyday educational activities in the contents. Teaching materials can be distributed to terminal devices that can be carried outdoors, such as cellular phones, portable media players, and portable game machines to support study that looks up at the actual starlit sky.

Moreover, contents can be offered in cooperation with planetariums where the everyday educational activities of curators were attained by structure in which the curators themselves can update contents by importing the contents of blogs, offering slides used in the planetarium, etc. This system can support curator educational activities from various fields.

In the future, unknown electronic terminal devices and systems may be invented. So that many people can use teaching materials, correspondence to such things is needed. Our developed system can correspond to that situation.

From a different perspective, astronomical information is universal. Since many people can use such teaching materials, it is important to prepare them in various languages. Therefore, we will improve the system in the future so that contents corresponding to internationalization can be generated.

Moreover, our system is constituted by the LAMP environment and open source software. We will offer an open source content management system to the public so that people who perform educational activities can use it.

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