Featured Articles

Involvement in Digital Textbook Business for Realization of the Vision for ICT in Education

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OVERVIEW: The consortium for the promotion of a digital text platform established by Hitachi and 12 textbook companies has been developing a common platform for digital textbooks, which play a central role in The Vision for ICT in Education promoted by the Ministry of Education, Culture, Sports, Science and Technology. The development of digital textbooks posed many difficult challenges that required the utilization of IT technologies, including achieving consistent operation across all textbook companies, textbook distribution, collaborative learning, and recording learning activity. Hitachi overcame these challenges one by one by proposing a common platform made up of a viewer and server, finalizing its specifications in consultation with the textbook companies, and conducting field trials, culminating in the successful completion of V1 development. The platform was introduced in elementary schools throughout Japan beginning in April 2015 and its use is still expanding. In the future, Hitachi intends to contribute to the establishment of educational infrastructure in the form of common platforms that serve as de facto standards by extending deployment to junior high schools and high schools.

INTRODUCTION

THE New Strategy in Information and Communications Technology[1] formulated by the government's Strategic Headquarters for the Promotion of an Advanced Information and Telecommunications Network Society (IT Strategic Headquarters) in 2010 considered how to provide schooling suitable to the 21st century. In response, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) formulated The Vision for ICT in Education[2]. This document emphasized the importance of fostering the capacity to utilize information and concluded that there was a need to establish a one-device-per-child environment in order to extend children's individuality.

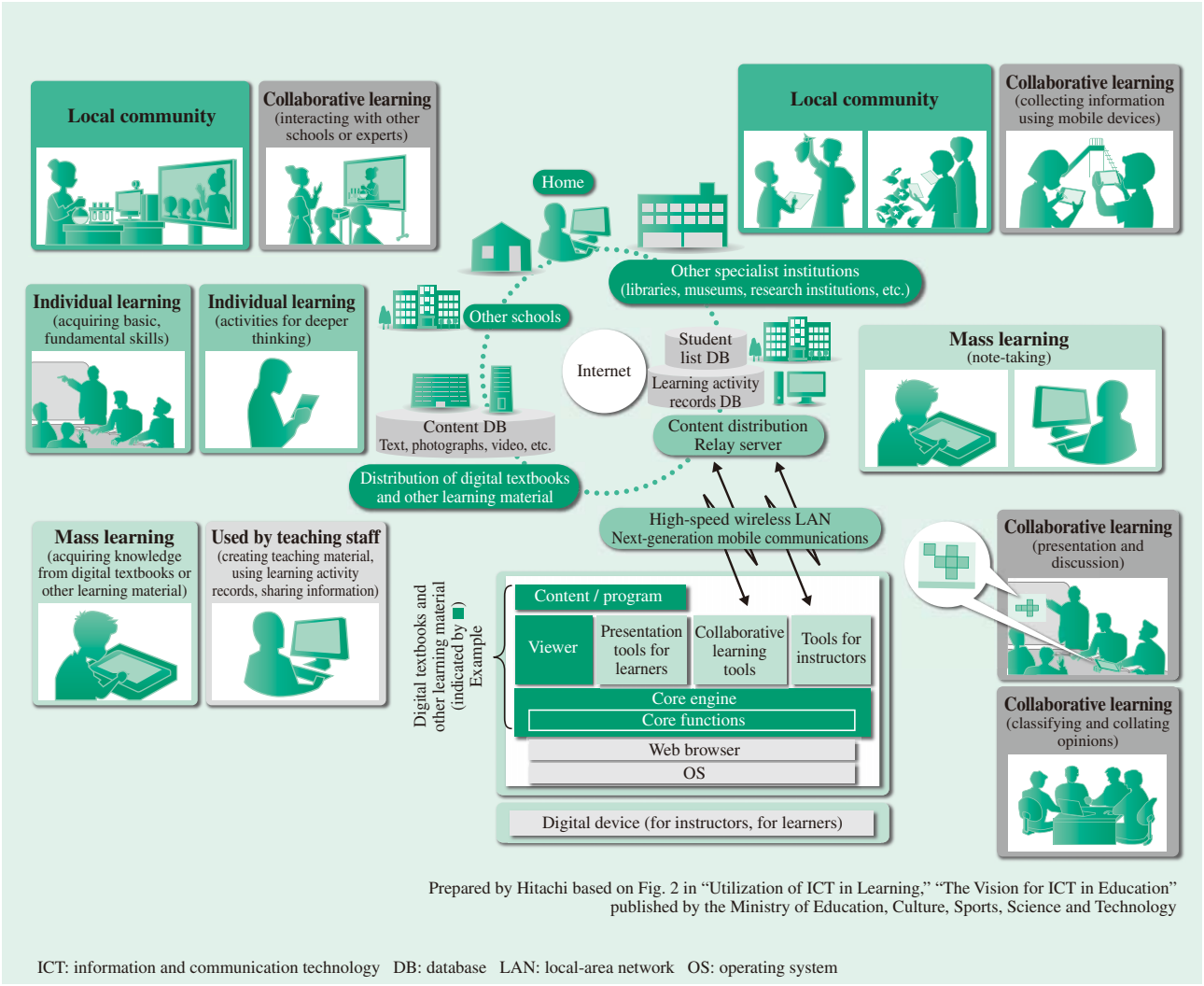
With regard to the format of textbooks and other learning material, it also identified the importance of field trials to evaluate the best form for both the digital textbooks for instructors used by teachers and the digital textbooks for learners used by pupils. Digital textbooks need to utilize information technologies (ITs) such as the cloud and other networks, and Hitachi believes they play a major role in establishing the social infrastructure of education. This article describes Hitachi's digital textbook business.

DIGITAL TEXTBOOKS AND LEARNING IN THE 21ST CENTURY

It is important that the education required by children living in the 21st century take advantage of the capabilities of information and communications technology (ICT), including bidirectional interaction and the ability to send information to remote locations and to large numbers of people instantaneously and simultaneously. The Vision for ICT in Education lays out what this means in practice.

Vision for ICT in Education

The "Learning Environment Suitable for the 21st Century and Learning Based Thereon" described in The Vision for ICT in Education (see Fig. 1) considers not only conventional "mass learning," but also "individual learning" that is tailored to the individual capabilities and characteristics of each child, and "collaborative learning" in which children study together. In each of these cases, the use of ICT is considered a prerequisite, with the digital textbook acknowledged as being the most important technology of all. Digital textbooks are a form of learning material for use on various types of digital devices that augment



Prepared by Hitachi based on Fig. 2 in "Utilization of ICT in Learning," "The Vision for ICT in Education" published by the Ministry of Education, Culture, Sports, Science and Technology

ICT: information and communication technology DB: database LAN: local-area network OS: operating system

Fig. 1—Learning Environment Suitable for the 21st Century and Learning Based Thereon (Example).
The use of ICT in teaching creates a learning environment that combines mass learning, individual learning, and collaborative learning.

the existing content of textbooks and software used for reading it with other core functions that include editing, transferring, adding, and deleting content.

What is Expected of Digital Textbooks

There are two types of digital textbook, one is for instructors that teachers use to present lessons along with use of an Interactive Whiteboard (IWB) and other resources, and the other is for learners that pupils use on a tablet computer. Along with displaying the content of the textbook itself, digital textbooks for instructors need the sort of functions made possible by digital devices, including displaying enlargements, taking notes, reading text aloud, and playback of video.

Digital textbooks for learners, meanwhile, need not only to support the enlargement, note-taking, and other functions provided by the textbook for instructors, they also need to be able to run on a range of devices, including the iPad[*1] as well as Windows[*2] tablets. They also need to support networking functions so that communication between teachers and pupils can be used to distribute exercises for pupils to complete and return. There is also scope for their use to provide more effective ways for pupils to express themselves by enlarging and displaying their answers on an IWB.

ESTABLISHMENT OF CONSORTIUM AND THE ROLE HITACHI PLAYS

To date, textbook companies have only developed digital textbooks for instructors. A problem with these is that they have been difficult to use, with each company adopting a different user interface.

*1 iPad is a trademark of Apple Inc., registered in the U.S. and other countries.
*2 Windows is either a registered trademark or trademark of Microsoft Corporation in the United States and/or other countries.

The requirements for the next generation of digital textbooks include copyright protection for the textbook's text and photographs as well as making use of networks and supporting multiple operating systems (OSs). As advanced IT is needed to implement all of these, it is very difficult for textbook companies to achieve on their own.

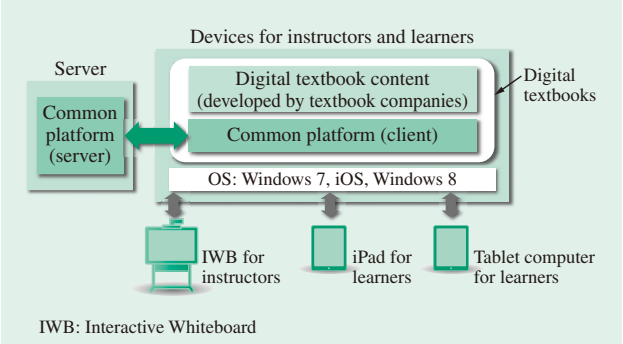


Fig. 2—Configuration Adopted for Consortium for the Promotion of a Digital Text Platform.
Hitachi provides a common platform and the textbook companies focus on developing content for sale.

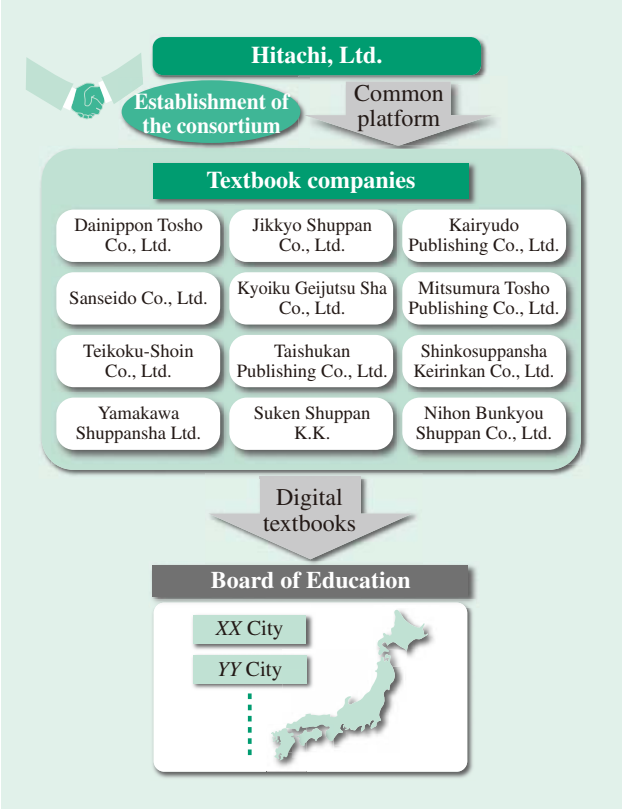


Fig. 3—Establishment of the Consortium.
The membership of the consortium for the promotion of a digital text platform includes 12 major textbook companies. Content is hosted on the common platform developed by Hitachi and marketed as digital textbooks throughout Japan.

Accordingly, it was proposed that a common platform be developed to enable textbook companies to overcome these problems. The approach adopted for this was to separate the textbook content from the control and management functions, which include display, operation, data management, communications, graphical user interface (GUI), and network control (see Fig. 2).

The advantage of this for textbook companies is that it resolves the IT issues and allows them to concentrate on developing content, while also reducing overall costs. The consortium for the promotion of a digital text platform was established on the basis that Hitachi would work with 12 textbook companies to prepare a set of common specifications, and that Hitachi would carry out the development[3] (see Fig. 3).

DEVELOPMENT OF A COMMON PLATFORM

Hitachi developed a common platform for digital learning material and provides it as a service to the consortium members (textbook companies) and others. The platform is made up of a viewer for displaying and manipulating digital learning material and a server system for managing and distributing the viewers and digital content (see Fig. 4).

The platform works by allowing textbook companies to register content so that it can be downloaded from the cloud for use by schools subject to a licensing procedure. Whereas the past practice when changes were made to a textbook was to distribute the update on a digital versatile disc (DVD) or similar format, the

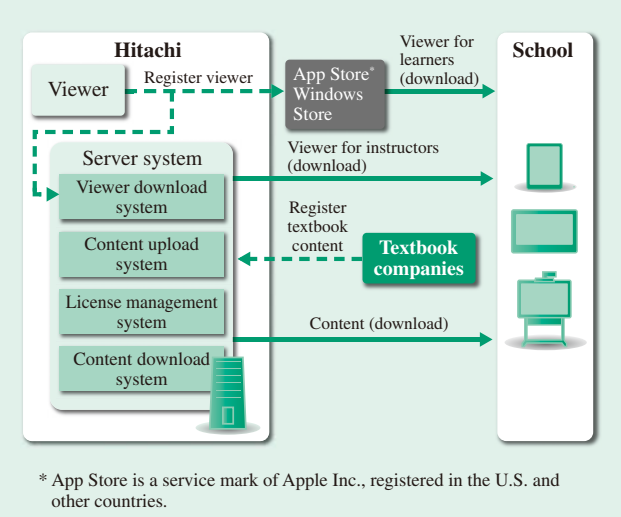
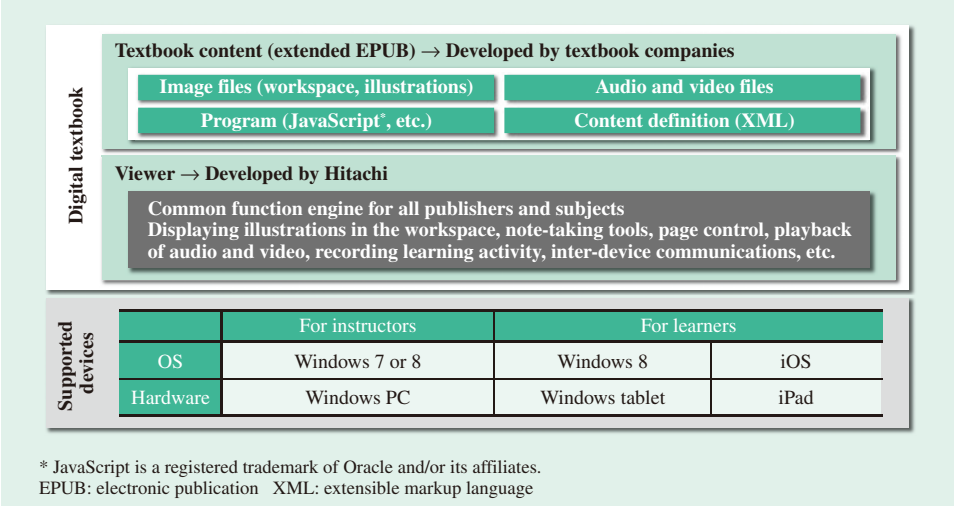


Fig. 4—Overview of Common Platform for Digital Learning Material.
The common platform for digital learning material is made up of a viewer and a server system.



* JavaScript is a registered trademark of Oracle and/or its affiliates.
EPUB: electronic publication XML: extensible markup language

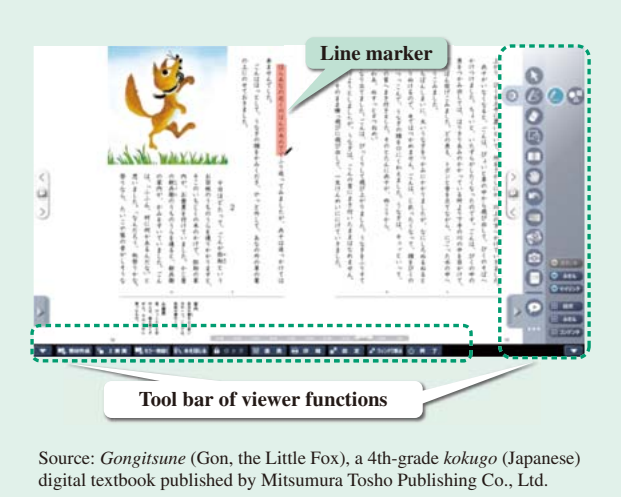
Fig. 5—Structure of Digital Textbooks.
Digital textbooks are made up of a viewer and the textbook content.

platform enables schools to choose when to download updates and saves textbook companies the cost of producing and distributing the DVDs.

Viewer Features

Whereas past digital textbooks have combined the viewer and content in a single application, a major feature of the newly developed digital textbooks is that the viewer and content are entirely separated. This provides a standardized user interface for the viewer and support for multiple OSs. It also helps to reduce development costs by allowing textbook companies to focus on content development. The viewer functions include functions for displaying workspaces the same way for all textbook companies and subjects, use of a pen for note-taking, page control, playback of audio and video, and recording learning activity. Individual viewers are provided for instructors and learners respectively. The instructor's viewer can run on Windows 7 and 8, and the learner's viewer on IOS[*3] and Windows 8 (Store), making a total of three OSs. Essentially, content from a single source can be used on any of the three OSs (see Fig. 5).

The main features of the viewers are as follows.
(1) Identical operation for all textbook companies and subjects (see Fig. 6)
(2) Inter-textbook linkage function for linking content across different grades and subjects (see Fig. 7)
(3) Inter-terminal communication function for the transfer of data between teacher and pupil or between pupils
(4) Page snapshot function and learning activity record storage function for recording entered notes or learning activity
(5) Editing function for allowing users to create learning material
(6) Copyright protection to prevent copying of content data



Source: *Gongitsune* (Gon, the Little Fox), a 4th-grade *kokugo* (Japanese) digital textbook published by Mitsumura Tosho Publishing Co., Ltd.

Fig. 6—Viewer Functions for Providing Standardized User Interface.
The tool bar provides pencil, zoom, and other functions.

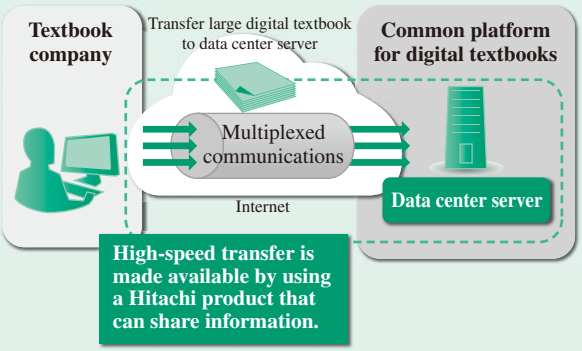
The data format specification used by the viewers is based on EPUB[*4] 3.0, an international standard for electronic books. Hitachi has also defined its own proprietary data format for those digital textbook features that are not supported by EPUB 3.0. Hitachi is also working on the standardization of some parts of this proprietary format for digital textbooks, including registering it with the International Digital Publishing Forum (IDPF), the standards body of the US electronic publishing industry, in January 2015.

*3 IOS is a trademark or registered trademark of Cisco in the U.S. and other countries and is used under license.

*4 EPUB is a registered trademark of the IDPF.

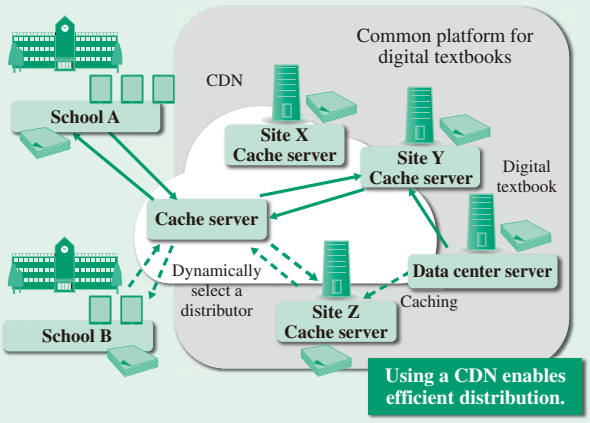
Source: *Kujiragumo* (The Whale-shaped Cloud), a 1st-grade *kokugo* (Japanese) digital textbook published by Mitsumura Tosho Publishing Co., Ltd. (left)
Weather Change, Wakuwaku Rika 5 published by Shinkosuppansha Keirinkan Co., Ltd. (right)

Fig. 7—Inter-subject Links.
Linking content across subjects can be used to display two different subjects (in this case Japanese and science) on two screens at once.



MIE: managed information exchange

Fig. 8—High-speed Transfer of Large Digital Textbooks.
A Hitachi product that can share information enables textbook companies to transfer large digital textbooks to the system at high speed via an Internet connection.



Solid lines indicate content delivery for school A, and dotted lines for school B.
CDN: content delivery network

Fig. 9—Efficient Digital Textbook Distribution.
Hitachi utilizes technology designed for content delivery networks to provide high-speed and reliable distribution of digital textbooks to schools throughout Japan.

Server System

The server system draws on Hitachi's expertized and trusted technologies and other products to ensure security as well as the efficient registration and distribution of textbook data.

The following describes three notable features.

(1) High-speed transmission of large digital textbooks

Because they include high-quality photographs, video, and other forms of content specific to digital formats, the data size of digital textbooks is often as large as several gigabytes. Furthermore, because the updating of content on the system occurs mainly during specific busy seasons such as March when textbook companies are finalizing the production of their digital textbooks, a mechanism is required for the reliable and high-speed transfer of large files.

This is achieved using a Hitachi product that can share information (see Fig. 8).

A Hitachi product that can share information allows even users who do not have communication links to transfer files efficiently using multiplexed communication techniques, achieving speeds that are several times, or several tens of times, faster than can be achieved using the conventional hypertext transfer protocol secure (HTTPS). This means that textbook companies located around the country can use an Internet connection to update large digital textbooks on the system, reliably, and at high speed.

(2) Efficient distribution of digital textbooks throughout Japan

The common platform can be used to download digital textbook data from the server. As the devices used in schools are commonly set up in March or April, or during the summer holidays, it is assumed that most downloading of digital textbooks will also take place during these periods. Accordingly, Hitachi has utilized technology designed for content delivery networks to provide high-speed and reliable distribution (see Fig. 9).

Efficient distribution is also achieved by providing the common platform with functions such as the ability to cope with the large size of digital textbooks by downloading only the required part, and a resume function for restarting an interrupted download.

(3) Ensuring the security of textbook data

Because the system server handles information that must be kept secure, including the digital textbooks and their licenses, it requires data security features, such as preventing tampering with textbook data and ensuring that access is only granted to textbook companies and the schools that purchase digital textbooks. The common platform for digital learning material maintains data security for the server system and textbook data by utilizing techniques and know-how from a Hitachi product that prevents data leaks. The platform also combines numerous different techniques, including the implementation of system-specific mechanisms for detecting tampering, to achieve a higher level of data security.

FIELD TRIALS

Field trials were conducted at elementary schools with the involvement of experts to assess which specific information technologies, and ways of utilizing them, work well in lessons that are based on the use of digital textbooks, IWB, and student devices; and to test the user interfaces of digital textbooks and how easy they are to use.

Details of these field trials are as follows.

(1) Sites

Tokyo Gakugei University

Koganei Elementary School, Tokyo Gakugei University

Dainana Elementary School, Kodaira City

(2) Field trial coordinator

Naoki Kato

Center for the Research and Support of Educational Practice

Tokyo Gakugei University

(3) Field trial period

July 2014 to the end of March 2015

(4) Digital textbooks used

Digital textbooks for instructors (see Fig. 10)

Digital textbooks for learners (for iPad) (see Fig. 11)

After participating in lessons, the pupils were surveyed about their impressions of the digital textbooks and the functions they provided. Overall, the responses were broadly positive, with the majority of responses reporting that lessons using digital textbooks were “very enjoyable” and that ”the textbooks were very easy to understand,” and with a high proportion of responses to the survey of viewer functions reporting that the sticky note function, line marker, and text input were “very easy to use.” On the other hand, there were a small number of responses reporting that the enlargement and curved line drawing functions were “somewhat difficult to use,” indicating areas for improvement.

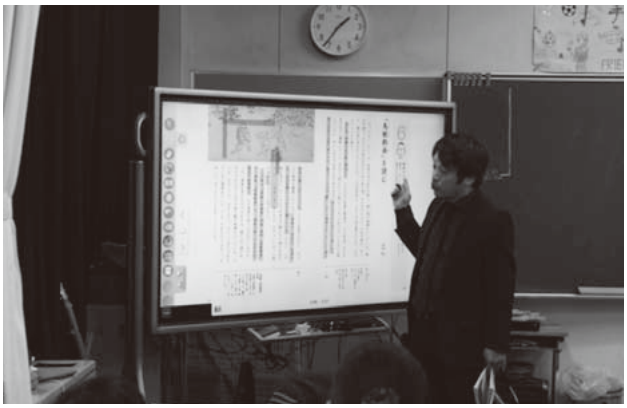


Fig. 10—Example Lesson Using Digital Textbook for Instructor.
A digital textbook for instructors is displayed on the IWB screen and the pen function allows the instructor to indicate the relevant points.

Fig. 11—Example Use of Digital Textbook for Learner to Answer Questions.
As instructed by the teacher, the pupil uses the marker function to highlight passages of text he/she can relate to or finds interesting. Unlike paper, this allows pupils to make as many changes as they want.

In the future, Hitachi intends to make further improvements to make the system easy to use in lessons and other forms of learning with reference to the views of experts and of school teachers and pupils from other similar field trials or from actual use in the field.

FUTURE DEVELOPMENT

This article has described the development of the first version (V1) of the core functions (viewer) and server distribution platform functions.

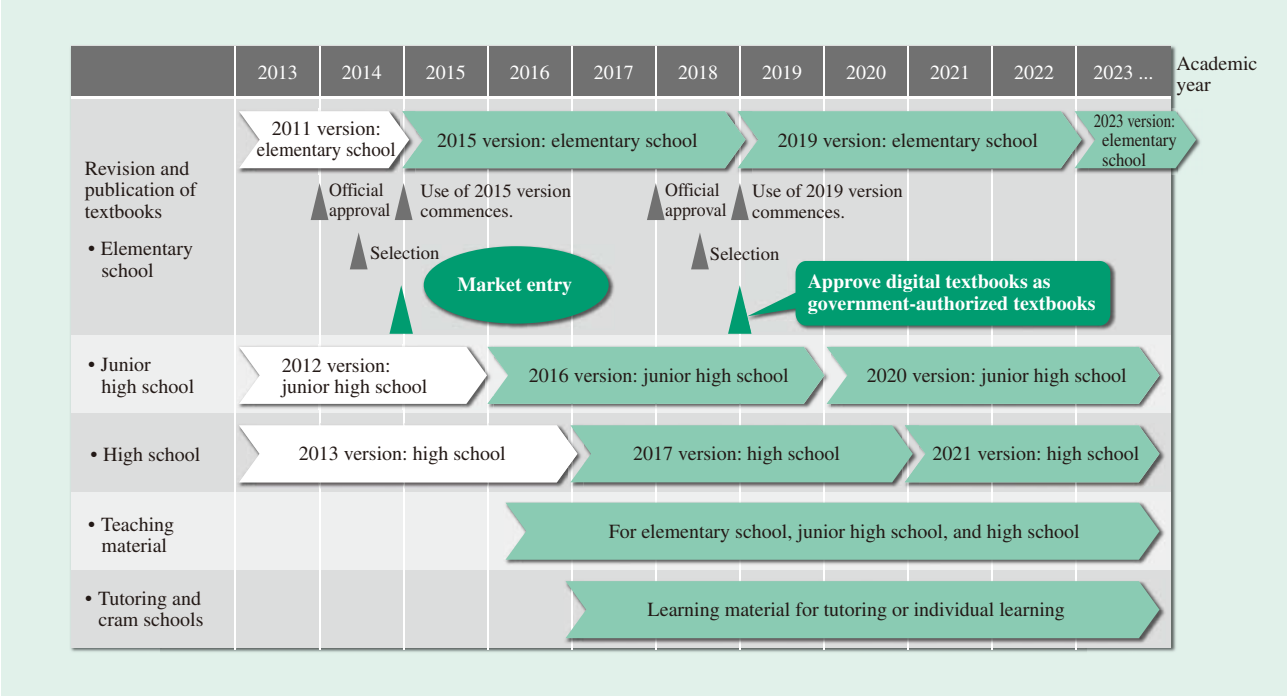


Fig. 12—Ideas for the Future and Plans for Wider Scope of Use.
Following the same practice as ordinary textbooks, which are revised every four years, deployment of the 2015 version in elementary schools will be followed up by the progressive release of versions for junior and senior high schools. There are also plans to publish teaching material for schools and tutoring classes.

Digital textbooks based on the viewer platform have been used for teaching at elementary schools since April 2015.

In 2016, Hitachi intends to consult with users with the aim of making the system even easier to use. Work currently in progress includes making enhancements to core functions and functional enhancements aimed at expanding use to junior high schools. The former include workspace reflow for student tablets and linking content to supplementary teaching materials such as existing digital textbooks and atlases.

The reflow function is intended to allow use of the system in special needs education. When the workspace display is enlarged, it reformats the layout of enlarged text so that it can be read without frequently scrolling to reposition the workspace. Content linking provides a broader scope for education by linking textbooks to supplementary teaching materials (such as dictionaries) on the bookshelf, enabling users to look up the usage of words in a dictionary, for example.

Hitachi aims to establish an environment that provides children with a broader range of learning options by working with the industry so that supplementary teaching materials, books, dictionaries, and other non-textbooks can be included on the bookshelf.

Among enhancements aimed at expanding use to junior high schools, Hitachi intends to develop a function that uses the audio required for English teaching to read highlighted text out loud using native-speaker pronunciation.

From the 2016 academic year onward, the plan is to extend the range of learning material available for use in other forms of education such as high schools, tutoring, and cram schools. In the case of high schools, in particular, the intention is to add support for recording learning activity, private sales, and other material suitable for a wider range of learning situations, including reference books, teaching material, and tests and exercises.

To facilitate use in tutoring and other types of cram schools, Hitachi is currently considering ways of collecting data on the learning activity records of individual students and using big data analysis to provide feedback to tutors on teaching materials and student learning practices (see Fig. 12).

Ideas for the future include strengthening server functions in anticipation of the adoption of the one-device-per-student policy and allowing distribution of content to the home. Hitachi aims to support adaptive learning in which students learn at their own pace and offer an extensive range of cloud services that

are available everywhere and all the time in order to expand use of the viewer so that it can become a widely used common platform in Japan.

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