The Development of an Interactive Digital Textbook in Middle School English

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Abstract. The purpose of this study was to design and develop an interactive digital textbook in middle school English for both the classroom and individualized (differentiated) learning. Most of digital textbooks developed so far have been mainly focused on the digitization of text like an e-book, but not sufficiently utilized the interactive features of computer. Therefore, in this study, we attempted to find a way to develop the digital textbook to support students' individualized learning as well as classroom learning by accommodating various needs of individual learners and English education. For this, we devised the design principles for the development of digital textbook based on the theoretical review, which consisted of two dimensions of activities (Representation of information and Expression of understanding) and three categories of cognitive aspects (Recognition, Strategy, and Affection). Then, we applied them to the development of the English digital textbook. In this paper, we introduced the examples of the design principles applied in it and some implications for the development of digital textbook.

Keywords: digital textbook, development of digital textbook, instructional design, differentiated learning, UDL, middle school English.

1 Introduction

The advancement of information technology offers opportunities for new ways of creating teaching and learning resources including digital textbooks. Digital textbooks are defined as the digitalized forms of printed textbooks, which can be read, seen and listened through wired or wireless networks [4]. The digital textbook has maximized convenience and learning effectiveness with additional functions such as navigation, multimedia and learning supports with the advantages of the printed textbooks [2].

The digital textbook can be more dynamic and interactive in its transition from the traditional printed books to digital textbooks. It can be used to promote students'

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learning by integrating various types of multimedia resources for classroom lessons. Moreover, by quickly adopting the changes in knowledge and information, it can reduce the cost of publication as well as the burden of students' heavy backpacks. With that expectation, the Korean government has been developing digital textbooks since 2007. The Ministry of Education, Science and Technology has launched 'a digital textbook project in 2007 and run a pilot test at almost 100 schools in 2011.

As one of the projects, we have developed a middle school English digital textbook. This digital textbook, the first middle school digital textbook, was designed for the differentiated learning as well as regular classroom teaching/learning. According to the current middle school curriculum of Korea, schools are recommended to provide differentiated learning in English because English is regarded to be the most difficult subject in Korea. With the globalization and the growing importance of learning English however, students' English proficiency does not seem to improve [5].

We assumed that the digital textbook can be a solution to problems of English because digital textbooks can provide various multimedia resources and materials as well as the support for learning according to learners' understanding levels. However, the digital textbooks developed so far are basically designed to duplicate the printed textbook itself. Thus, we tried to find a way to design digital textbook to be a useful tool to support effective English learning in both individualized (especially differentiated) learning and classroom learning.

In this paper, we will introduce the design strategies to develop the digital textbook for both the classroom and individualized (differentiated) learning with some examples. And then, we will suggest some implications for the development of digital textbook.

2 Design Principles for a Digital Textbook

The purpose of this study is to develop a middle school English digital textbook for the use of both classroom and differentiated learning. For this, we attempted to find a way to accommodate various individual learners' needs as well as the needs in English education. We appreciated the UDL (Universal Design for Learning) as a foundational theory for our work because it provides conceptual framework as to how to design support for diverse students.

Universal Design for Learning (UDL) is originally developed for helping handicapped students (physically and mentally) in the special education to learn learning standard curriculum that designed for typical students in schools [6]. The key concept of UDL is to acknowledge the differences of learners and provide various teaching and learning methods to reflect those differences.

Rose & Meyer (2002) developed the UDL principles based on the neuro-science research suggesting that our brain consisted with three parts of recognition, strategic, and affective networks. Recognition networks are specialized to sense and assign meaning to patterns we see, so they enable us to recognize patterns and understand information. Strategic networks are specialized to generate and subsume mental and

motor patterns, so they enable us to plan actions and systematically act on information. Affective networks are specialized to evaluate patterns and assign them emotional significance, so they enable us to engage with tasks and learning. These three networks are structurally and functionally distinguishable but closely connected and functioning together. The implication of this brain research is that we need to support learning with various ways to promote these networks' functions and the way to reflect various learners' needs is to provide learning materials and contents in various ways [1].

We assumed that the functions of three brain networks can be applied to general education as well as special education. Generally, students use those networks to understand and integrate new formation into their knowledge. However, UDL was not enough to draw design principles for digital textbooks because it did not suggest enough information about the instructional design for digital textbooks. Thus, we reviewed instructional design theories that may be related to the principles of UDL and developed principles for the design of digital textbooks [3].

For the design of digital textbooks, we assumed that these factors can be considered in two ways [3]. First, we need to consider learners' cognitive process for understanding when we present information in the digital textbook. That means we need to design information to facilitate their learning by promoting the three brain networks, such as recognition, strategy, and affection. Second, we need to provide opportunities for students to express their understanding, by which we could know if learning is occurred. Even for the expression, we can consider each aspect of brain networks.

Based on these reflections, we have drawn a design guideline to support learning for a digital textbook as the Table 1. It consists of two dimensions of activities (Representation of information and Expression of understanding) and three categories of cognitive aspects (Recognition, Strategy and Affection).

Table 1. Design principles for a digital textbook

	Recognition	Strategy	Affection
Representation of information **Definition** The way to present and organize information	**Definition** The way to help the acknowledgement, recognition and understanding of information when the information is provided. **Strategies to support** R.R.1. Provide learning objectives. R.R.2. Represent content by using various media.	**Definition** The way to help the meta-cognition, strategic learning and reflection of information when the information is provided. **Strategies to support** R.S.1. Provide opportunities to grasp critical concept.	**Definition** The way to help the emotion, engagement and attitude on the information when it is provided. **Strategies to support** A.1.Provide multiple learning/teaching methods

Table 1. (*continued*)

	Recognition	Strategy	Affection
	R.R.3. Present the same content in different types of media. R.R.4. Emphasize important contents. R.R.5. Simplify complex tasks by using multiple steps. R.R.6. Provide prior knowledge and background information R.R.7. Provide authentic tasks and contexts. R.R.8. Provide various examples.	R.S. 2. Provide opportunities to summarize learning contents. R.S.3. Provide opportunities for practice. R.S.4. Provide opportunities for reflection. R.S.5. Provide various tools necessary for learning (note-taking, highlight, monitoring etc.) R.S.6. Provide opportunities to observe experts' performance.	A.2. Provide appropriate difficulties to learners' levels. A.3. Provide learner control for learning objectives, time, sequence, difficulties, etc. A.4. Provide user-friendly interface. A.5. Provide opportunities for success. A.6. Provide learning outcomes. A.7. Provide examples or tasks related to learners' experience. A.8. Provide opportunities for collaboration with peers.
Expression of understanding **Definition** The way for students to express their understanding	**Strategies to support** E.R.1. Provide learners with opportunities to demonstrate their understanding E.R.2. Provide various expression tools (writing, speaking, drawing, etc.) E.R.3. Provide various communication tools for interaction among participants. E.R.4. Provide opportunities for learners to see the result of response.	**Strategies to support** E.S.1. Provide prompting to promote learners' thinking. E.S.2. Provide opportunities for learners to share and compare their results E.S.3. Provide appropriate cognitive support for learners' levels.	

Note. First letters of each category are used for numbering. For example, R.R.1 represents the strategy under the category of Representation of information by Recognition.

3 Development of English Digital Textbook

The English Digital Textbook was developed in a Window OS environment with Flash applications and web-programming. It includes 12 lessons, each of which consists of 8 class-hours in middle school English. The Digital Textbook is delivered through a learning platform that provide learners involved in the use of the Digital Textbook with on-line services, learning and navigation tools to promote their successful performance. All of digital textbook developed by Korean government is serviced with this learning platform.

3.1 Listen & Speak

The 'Listen & Speak' section is developed for learners to practice listening and speaking in English. In listening practices, each activity requires learners to listen to the spoken version of the given sentences first and then to respond to questions related to it. In this section, we tried to provide various supports for learning. Fig. 1 shows an example of listening practice and scaffolds to facilitate students' learning.

Fig. 1. A screen shot of listening section in the Digital Textbook

The graphic icons(boxed) at the left-bottom of the screen include buttons for play to listen. It includes speed control buttons, hints, and script buttons as well as play button in order to allow students control the learning process according to their abilities. (*E.S.3. Provide appropriate cognitive support for learners' levels; A.3. Provide learner control for learning.)* While learners can see the script of a listening text in a pop-up window by clicking the 'Script' button, they can look at a Korean translation of the text in the script window by clicking the 'Kor' button. Students can see those scaffolds only when they had chosen incorrect answer. Also, students can read the question by Korean by clicking the button(boxed) in the right upper side of the screen.

Fig. 2 shows a screen shot of speaking section in the 'Listen & Speak' unit. In speaking section, learners can choose three options for speaking practice as shown in the right side of the screen (boxed). When click the 'Listen' button, learners can listen the conversation with animated graphics. (R.R.2. Present content by using various media; A.4. Provide user-friendly interface; R.S.6. Provide opportunities to observe experts' performance.) When clicking the 'Listen and Repeat' button, learners can choose a character of the scenario and participate in the conversation. If the learner has difficulties to understand the conversation, they can look at the script by clicking script button at the left-bottom of the screen. (E.S.3. Provide appropriate cognitive support for learners' levels.) The 'Talk with a foreigner' button shows a video of a native speaker. Learners are asked to speak with the foreigner to complete the conversation. (A.7. Provide examples or tasks related to learners' experience.)

Fig. 2. A screen shot of speaking section in the Digital Textbook

In speaking section, learners can also practice speaking with their friends at a distance using an on-line video chatting tool.(A.8. Provide opportunities for collaboration with peers.) In addition, video clips showing the shapes of a native speaker's mouths as they pronounce key vocabularies and expressions in each lesson were presented to help learners improve their pronunciation and speaking skills.(R.S.6. Provide opportunities to observe experts' performance.)

Learners can choose some learning tasks according to their English proficiency. The learning tasks are classified into low, middle and high levels, which is designated by Y (yellow), B (blue) and O (orange) in the upper-right hand corner of screen. The differentiated learning tasks allow learners to engage in learning with appropriate learning difficulties. (*A.2. Provide appropriate difficulties learners' levels.)*

3.2 Read & Do

The 'Read & Do' section is designed to develop reading skills in English. Reading requires lots of cognitive strategies to understand. Therefore, in this section several tools and buttons were designed to support reading strategies. First of all, before the presentation of main reading text, learners are asked to think about the theme by presenting prompting questions and pictures as a pre-reading stage. (*E.S.1. Provide prompting to promote learners' thinking; R.R.6. Provide prior knowledge and background information.*) After that, main reading text is presented with several scaffolding buttons for strategies on the right side (boxed) of the screen in Fig.4.

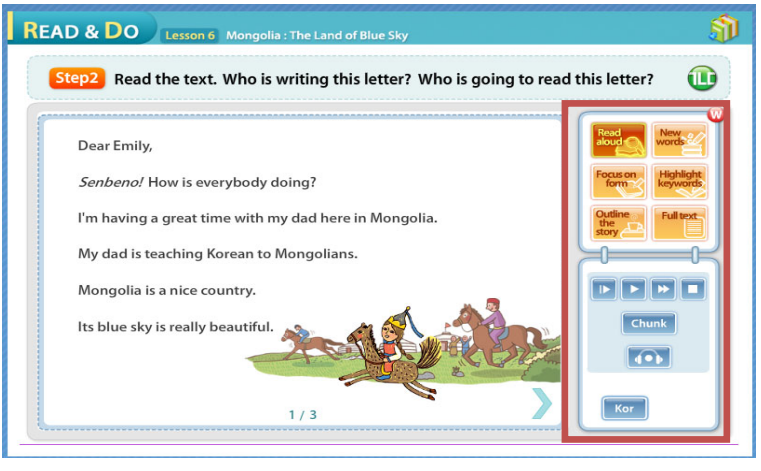

Fig. 3. A screen shot of 'Read & Do' section in the Digital Textbook

For example, when learners click the 'Read aloud' button, the paragraphs are spoken by a narrator. Learners can control the speaking pace using video buttons in the middle of the right side of the screen. Learners also can see the segment for effective reading by clicking 'Chunk' button under the video buttons. Learners can read by themselves by clicking 'headset' button. (*R.R.2. Present content by using various media; R.S.6. Provide opportunities to observe experts' performance; A.3. Provide learner control for learning*)

'New words' and 'Focus on form' buttons present new words and language forms by underlining in the reading text. When learners click the 'Highlight keywords' button, they can use a marker and an eraser to highlight meaningful sentences and expressions in the text. 'Outline of the story' button shows the whole structure of the contents. Even though the reading text is presented basically on separate pages, learners can look at the whole text on one page by pressing the 'Full text' button.These buttons were designed to help and support learners to comprehend reading text by stimulating strategy and affection. (*R.S.1. Provide opportunities to grasp critical concept; R.S.5. Provide various tools for necessary for learning.)*

Another additional tool for reading is the dictionary. The 'W'button on the right-upper corner of the screen shows the meaning of the word when learners click the words that they don't know after clicking the button. (*R.S.5. Provide various tools necessary for learning.*) Virtually, this button works not only in the reading section, but also in the whole section of the textbook. After reading, some questions related to the reading text are provided, which allows learners to express and check their understanding. (*E.S.1. Provide learners with opportunities to demonstrate their understanding; R.S.4. Provide opportunities for reflection.)*

3.3 Think & Write

Writing skills are enhanced in the 'Think & Write' section. Writing is a complex problem solving process, which requires planning, transcribing and reviewing steps [14]. Thus, in this section, we attempted to support learners' learning by presenting authentic tasks that they may use in real-life writing and provide sub-steps to complete the learning task. For example, learners can practice writing a letter, following several sub-steps pre-designed in the Digital textbook. After finishing all the sub-steps they can get the outcome of their learning which is a completed letter. (*R.R.5. Simplify complex tasks by using multiple steps; R.R.7. Provide authentic tasks and contexts; R.R.8. Provide various examples; A.6. Provide learning outcomes; A.7. Provide examples or tasks related to learners' experience.*)

3.4 Let's Check

'Let's Check' section is developed for assessing learning outcomes. Several test items with various levels of difficulty require learners to apply and integrate the four English skills: listening, speaking, reading and writing. No cognitive scaffolds are available while they are answering questions in this section. The results are shown after the learners have answered all the questions. Once all the questions have been solved, learners can get feedbacks and try to answer the questions again. (E.R.1.Provide learners with opportunities to demonstrate their understanding; E.R.4. Provide opportunities for learners to see the result of response.)

4 Discussion

In this paper, we have introduced the strategies to develop middle school English digital textbooks to support both classroom learning and differentiated learning. We attempted to find theoretical principles for the design of a digital textbook and to apply specific design strategies into the digital textbook. The design guideline was a useful tool to communicate as to how to design the contents and support available for the instructional designers, subject matter experts and programmers. It also served as a guide to contemplate the problems and difficulties that students confront when they study English in order to design the required support.

According to our pilot test, students had no difficulties to use the design features of the digital textbook in general. However, some features were not sufficiently utilized

as we intended due to the lack of technical support (such as the small size of the window, type-in errors) and lack of motivation towards the use of objectives and warm-up questions. This suggests that we need a further analysis on what features students choose to use in the respective situations. Moreover, since some features of this program were designed for the classroom use (such as learning objectives, warm-up questions, some strategies for reading, etc.), the usability test in the classroom teaching situation should be conducted.

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