South Korea has adopted the widespread use of digital textbooks. Part school reform and part an effort to prepare today’s children for tomorrow’s challenging world, the way in which this effort was implemented and the lessons learned are valuable. This article highlights the history of the digital textbook project and compares printed textbooks and digital textbooks in terms of pedagogy and their effects on student learning. The article reviews research that found that digital textbooks have a positive effect on students’ metacognition, self-regulated learning, self-efficacy, information exploration, problem-solving, intrinsic motivation, and self-reflection. In addition, our research found that the impact of digital textbooks varied according to whether students were in urban or rural schools and was also dependent on their achievement level. With this basis, the article discusses the opportunities and challenges of the digital textbook, and suggests some models of implementation. It is hoped that the exploration of South Korean educators’ approaches to educational reform with innovative digital textbooks will stimulate further work on integrating technology in education.

KEYWORDS digital textbook, technology integration, multimedia, information and communication technology, 21st century classroom

The twenty-first century poses a challenge for existing education systems. In the United States, educational leaders from both private and public...
organizations have issued warnings about the irrelevance of today’s education system, which creates a gap between how students live and how they learn. Educators have asserted that the prevailing teaching methods and contexts of American education, similar to those used 100 years ago, will not prepare students for a multitasking, multifaceted, technology-driven, diverse, and vibrant world. They have called on school systems to change dramatically, in effect, to make a paradigm shift, so that students are well-prepared to enter the global workforce of the 21st century where they will have to adapt to the accelerating pace of technical change, rapidly accumulating knowledge, and increasing global competition (Partnership for 21st Century Skills, 2003). The South Korean Ministry of Education, Science, and Technology (MEST) has made an innovative paradigm shift in South Korean education in order to meet the needs of the 21st century. The key for MEST was a school reform effort based on the adoption of cutting-edge technology. A prime example is the digital textbook program, which was announced by the Education Ministry of South Korea on March 8, 2007 (South Korean Educational Research Information System [KERIS], 2007).

Digital textbooks can bring changes to basic teaching practice, not only in contemporary South Korean schools but in schools throughout the world. We believe that there are important lessons to be learned by examining how South Korean educational reform was driven by the integration of technology in education. The process by which the digital textbook was adopted sheds light on both the challenges and opportunities in achieving educational reform through technology. In order to better understand this paradigm shift in education, this article will highlight the development of the digital textbook project, compare it to the use of printed textbooks, note its limitations, examine the learning theories that support digital textbooks, and investigate the impact on student learning. Finally, we will look at implementation strategies for introducing new technologies like digital textbooks.

Digital textbooks allow students access to learn content that is tailored to their abilities and interests. In addition to all the best features of the printed textbook, digital textbooks also offer various interactive functions, and provide the learner with reference books, workbooks, dictionaries, and multimedia contents such as video clips, animations, and virtual reality (Byun, Choi, & Song, 2006). Further, they do this both at school and at home, without the constraints of time and space. In other words, digital textbooks are alive and in motion; and, as such, are literally “living and moving” textbooks that construct and create knowledge not only for individual learners, but also for the community, as well as support and help manage teaching activities. Learners can create their own “textbooks” while using the digital textbook, underlining the important parts, taking notes, and ultimately combining the content with high-quality, reliable knowledge that is their own.
THE EMERGENCE OF DIGITAL TEXTBOOKS IN SOUTH KOREA

A Foundation for Cultivating Human Resources

South Korea lacks natural resources to compete in the global economy; therefore, South Korean educational leaders have pursued economic growth and national development by cultivating human resources in a 21st-century knowledge-based society. South Koreans believe education for the next generation is the basis of economic growth. The South Korean MEST has exerted enormous efforts to build a foundation for global competitiveness by cultivating human resources. A major thrust of these efforts was to create a systemic technological infrastructure to support an educational system based on advanced information communications technology. This technology was integrated into classrooms in various ways, including adopting teaching and learning methods based on cutting-edge technology and implementing of digital textbooks. These cases were awarded the first UNESCO-King Hamad Bin Isa Al-Khalifa Prize (South Korean Educational Research Information System [KERIS], 2008).

Limitations of the Printed Textbook

Traditionally, education has depended on printed materials. Because of the time and money required by the publishing process, printed books are expected to be used for anywhere from several years to a decade. However, as the pace of change increases, all too often the content of the book is already outdated by the time the book is published. Printed textbooks are not an effective medium in the context of our rapidly changing society and the increasingly short life cycle of knowledge.

In addition, no book can physically contain the total volume of information required for any course. Digital textbooks were introduced to overcome these limitations. Due to their compressed storage capacity, digital books can carry more information than hundreds of printed books. The multimedia-based digital book, particularly, is expected to increase the effectiveness of production and distribution of information as text can be supplemented by various media such as animation and video. As the technology has advanced, interactivity has become a more and more important component of digital technology (South Korean Educational Research Information System [KERIS], 2007).

The Changed Role and Cognition of Net-Generation Learner

The educational system of the 21st century must prepare life-long learners who are capable of processing vast amounts of knowledge on a daily basis. In the traditional South Korean educational system, the student is a vessel
receiving the knowledge the teacher transmits. Therefore, good students are characterized by skills such as listening attentively, summarizing content, taking notes, and taking tests. In contrast, 21st century learners need to be self-directed, active problem solvers, and knowledge generators who design their own learning goals. Recent educational research focuses on how learners generate and share knowledge in learning environments (Cañas et al., 2004).

In particular, this characteristic of self-regulated learners is key to the definition of the Net-generation as it has come of age on the Internet. Net generation is another name for Generation Y who has grown up with information technology. Reared in cyberspace, the Net-generation thinks differently from the old generation (South Korean Educational Research Information System, 2007). Computational media are creating new forms of cognitive activity and a new cognitive culture (Shaffer & Kaput, 1999). Theorists argue that personal computers, personal digital assistants, Game Boys, and the Internet may displace formal schooling as the primary means of developing thinking skills (Gee, 2003; Papert, 1996; Shaffer, 2004). Spreadsheets and statistical analysis tools may shift emphasis in mathematics from algorithmic fluency to mathematical modeling (Kaput, 1996; Lehrer & Romberg, 1996; Papert, 1980; Shaffer & Kaput, 1999). Video games and word processors may move the focus of language arts from reading and writing the printed word to participation in multimodal literacy spaces (Bolter, 1991; Gee, 2003; Kress, 2003; Murray, 1999). As a result, a simple understanding of who we teach and how we teach has become a much more intricate undertaking. The new computational media demands students with new habits of mind and the ability to master new skills such as programming and algorithmic thinking (diSessa, 2000; Papert, 1980). Digital textbooks play a key role as a cultural tool in a world that supports a new form of thought and a new cognitive culture (Donald, 1991). In addition, digital textbooks support self-regulated learners by facilitating the features that multimedia and hyper-text provide, such as flexible, interactive, manipulative, constructive, active, and searchable elements that are necessary to build self-regulated learning environments. Self-regulated learners can be characterized as effective problem-solvers and information creators and managers who effectively perform activities such as task identification; information seeking; and utilization, synthesis, and evaluation of information in authentic learning environments. Digital textbooks allow students to immerse themselves in this self-regulated learning environment.

Changes in Education’s Goals and Methodology

Traditionally, the goal of education was to transmit and acquire a body of accumulated knowledge through a curriculum that did not change very quickly. The knowledge students acquired in school was still relevant to their
work in society after graduation. However, this simple process of knowledge acquisition is not sufficient in the 21st century. Students are required to construct knowledge to solve problems in the world of the 21st century. As the environments in which students must function change, so too must the goals of their education. The question becomes: What educational objectives are appropriate for students who will daily face a host of often unpredictable situations? In this digital age, knowledge expands less because of conceptual changes and more in response to the daily contextual problems learners face. The solution to contextual problems in a rapidly changing society requires a curriculum based on knowledge that crosses the various domains, and that helps learners to generate new knowledge through synthesis. In other words, schools must be able to help students acquire the ability to create, synthesize, and integrate knowledge (KERIS, 2007).

As educational goals have changed, the methods of education must also advance. Previously, the goals could be met by rote memorization, drill, and practice. Simply repeated practices that do not appeal to intrinsically motivated learners, however, are no longer useful. Just as obsolete are the systems of reinforcements and punishments that once sustained instructional activities. In the face of a rapidly expanding and changing knowledge base, comprehension and application of knowledge become key. What is necessary are teaching methods that help students build their comprehension skills and increase their ability to apply knowledge through explaining and elaborating on information; through participating in group discussions; and through contextual, experiential, problem-based, and project-based learning. It is the new approach that underlies the belief of South Korean educators that digital textbooks are powerful tools that can connect students with real-world problems through the Internet, and through multimedia.

An Aim to Reduce Private Educational Costs

Bray (2005) and Tansel and Fatma (2006) suggest that there is a strong demand for private tutoring in much of East Asia and in European countries. Competitive entrance examinations to prestigious universities, the credential society, and credential inflation have been proposed as primary causes of the demand for private tutoring. The highly competitive college entrance exam in South Korea has generally led students to rely on private tutoring. The problem of private tutoring has been a focus of much discussion in South Korea. Private tutoring is accused of distorting school curricula and normal classroom activities as well as adding a heavy financial burden on household economies. Spending on private tutoring alters the structure of consumption and exerts a harmful influence on the household’s economic welfare. A survey conducted by the South Korean Education Development Institute (2003) reported that 84% of parents consider private tutoring expenses an economic burden. Moreover, expensive private tutoring is likely to reinforce
educational inequality between the rich and the poor, and the rural and the urban. Digital textbooks are considered an effective means to reduce private educational costs and narrow the educational divide. Digital textbooks will improve the quality of public education, and in the long run will enable a learner-centered, self-directed learning model (KERIS, 2008).

Strategic Implementation Phases of Digital Textbook Projects and Expected Outcomes

In pursuit of its vision to export the digital textbook to other countries, the South Korean government established a systematic implementation plan for the development of digital textbooks between 2007 and 2011. The first phase of digital textbook development was to choose schools in which to test the feasibility of digital textbooks in actual classroom applications. The initial project included fifth and sixth grades in 20 test sites. In addition, the initial project also included the development of digital texts for three subjects in middle school and two in high school. Later, the number of test sites was expanded to 100 schools. The second phase was to train teachers and consultants to use the digital textbooks in a pedagogically effective way. Numerous trainings were held for teachers and management consultants, both online and in traditional face-to-face sessions. The third phase involved building the infrastructure to support digital textbook use. A tablet personal computer was provided to each student in each classroom. In addition, schools were wired so students could access the Internet. The fourth phase was to develop a distribution system for the textbooks and quality management systems with standards for implementation. The fifth phase dealt with legal aspects of the implementation (copyright issues, hacking protection, etc). In addition, to encourage use of the digital books, a system to reward teachers for exemplary implementation was established. Extensive efforts have been made to develop the law and regulations as well as the public support and a national consensus around the use of digital textbooks. The sixth phase established an assessment system to analyze the effectiveness of the digital textbook.

The expected outcomes from the digital textbook implementation were as follows:

1. To create a future-oriented and learner-centered learning environment that is available at school, at home and anywhere in the community.
2. To begin to develop an overseas market by enhancing mobile telecommunication devices and display industries, expanding the e-book market, and diversifying South Korea’s domestic digital contents now primarily confined to games and movies.
3. To bridge the learning and digital gap plaguing low-income families and encourage a change in the paper-based or online tutoring market and in the publishing houses of authorized textbooks.

THEORETICAL FOUNDATION OF DIGITAL TEXTBOOK FEATURES

Much theoretical attention has been given to how and under what conditions learning can be maximized. It is critical to discuss how educational theories support the use of digital textbooks. While the topic is too large and complex to be thoroughly examined in this article, we can highlight those theories that are particularly relevant to specific features of digital textbooks such as hypertext, multimedia, interactivity, and self-regulated learning.

Learning with Hypermedia

One of the most beneficial features of the digital textbook is its non-linear characteristic mechanism: the so called “hypertext.” A hypertext environment provides different ways to approach content; its nonlinear characteristics allow different individuals to interact with the same information through different processes. Users are normally free to create their own reading structure and sequence. In fact, hypertext changes the conventional processes of structuring knowledge and understanding (Calcaterra, Antonietti, & Underwood, 2005; Muller-Kalthoff & Möller, 2003; Potelle & Rouet, 2003; Salmerón, Canas, Kintsch, & Fajarod, 2005).

In comparison to traditional print textbooks, digital textbooks permit much more flexibility in the delivery of instruction by enabling users to select hypertext links. This flexibility offers learners a rich environment in which to explore and encourages them to navigate by association. In this way, they can construct their own individualized knowledge structure by cross-referencing related topics in their knowledge base. Learners can still follow paths through the subject content produced by designers, but they can also develop their own routes according to individually prescribed requirements (Large, 1996). A number of studies have demonstrated superior learning from hypermedia compared to linearly presented information (Crosby & Stelovsky, 1994; Frey & Simonson, 1994).

Further, Baylor (2001) found learning costs if users applied a linear navigation mode (proceeding through the hypermedia as when reading a textbook) on hypermedia content because participants become moderately disoriented. Such disorientation did not occur when navigation took a non-linear form and participants had access to all pages of the hypermedia package. As a result, those who used a non-linear navigation mode performed better than those who used the linear mode on an incidental learning task.
However, it could be argued that the superiority of the non-linear presentations in these studies was due to increasing familiarity with hypermedia systems. A more sustainable line of reasoning might be that presented by Jonassen (1988, 1991) who argued that hypermedia should facilitate learning because of its correspondence with human associative memory structures. In other words, it is similar to the natural human modality of encoding and retrieving information.

When a learner is given the opportunity to move freely through a hypermedia presentation, he/she should develop personal navigation patterns whose features mirror his or her own cognitive characteristics. The flexibility offered by hypermedia, it might be argued, should enhance learning as it allows a correspondence between the individual’s imposed structure on the materials to be learned and his or her own cognitive profile. Put more succinctly, individual differences in cognitive style should lead to distinctive navigation patterns and these, in turn, should result in differences in learning outcomes (Parkinson & Redmond, 2002).

Several instructional benefits have been postulated for hypermedia learning from different theoretical perspectives. These perspectives mainly focus on the fact that hypermedia environments allow for active, constructive, flexible, adaptive, and self-regulated learning (Azevedo, 2005a; Scheiter & Gerjets, 2007). Lawless and Brown (1997) assumed that when using hypermedia as a learning device, the opportunity to determine information access allows the learner to actively control the learning process rather than being directed by a teacher or the argumentative structure of a textbook (cf. Cunningham, Duffy, & Knuth, 1993). It is believed that hypermedia structures enhance and stimulate a self-controlled and non-linear interaction with learning materials as well as an in-depth exploration of vast amounts of information.

Learning with Multimedia

Digital textbooks are designed to facilitate various multimedia productions such as interactive games, videos, audios, animations, 3D, and so forth. Research on multimedia learning suggests that multimedia can foster cognitive change (Mariano, Doolittle, & Hicks, 2009; Mautone & Mayer, 2001) and facilitate information processing in learning (Mayer & Moreno, 2003; Rieber & Kini, 1991). According to Mayer’s (2001) theory of multimedia learning, the learner’s ability to generate mental representation of external information is enhanced when incoming information is presented through multiple sensory channels, an assumption that aligns well with Paivio’s (1986) dual coding theory. According to Paivio (1986), multimedia use two different modes to represent the content knowledge: verbal and non-verbal. In the same vein, in the modality principle of instructional design (Low & Sweller, 2005; Mayer, 2001, 2005; Moreno, 2006; Moreno & Mayer, 1999, 2002a, 2002b), the most
effective learning environments are those that combine verbal and nonverbal representations of knowledge using mixed-modality presentations. Under the premise that multimedia presentations do not overload students’ cognitive capacity during learning, multimedia benefits may accrue not just from such explicit cues, but also due to the nature of human information processing such as visual and spatial subsystems in working memory (Baddeley, 1992). There are, as well, limitations to multimedia’s effectiveness, and therefore emphasize the importance of careful design and implementation of format and modality combinations (Novick & Morse, 2000; also see Mayer & Moreno, 2002).

Learning Through Interactivity

The digital textbooks’ abilities to provide interactivity and feedback open many possibilities in learning. It is believed that providing interactive, manipulative function in multimedia can improve learners’ problem-solving skills by (a) promoting their self-efficacy and (b) reducing the cognitive load involved in the problem-solving process (Zheng & Zhou, 2006; Zheng, Miller, Snelbecker, & Cohen, 2006). Multimedia with carefully designed interactive components offer visibility in learning: (a) Users are able to “see” the actions that are open to them at every choice point, (b) they are able to receive immediate feedback about the actions they have just taken—since few things upset computer users more than not knowing what a computer is doing when it seems to be churning unexpectedly, and (c) they are able to get timely and insightful information about the consequences of their actions (Norman, 1988; Hutchins, Hollan, & Norman, 1986).

Educational researchers have postulated the importance of combining interactivity and feedback in learning. Despite the ability to interact with the instructional materials (behavioral activity), learning may not occur if opportunities to obtain feedback and to reflect (cognitive activity) are absent. Therefore, the interactivity principle needs to be considered in combination with the principles of guidance and reflection. For example, novice students often become lost and frustrated and eventually resort to ineffective trial-and-error strategies when asked to discover scientific principles without guidance (Moreno & Valdez, 2005).

There are five common types of interactivity in multimedia environments: dialoguing, controlling, manipulating, searching, and navigating. By dialoguing, the learner can ask a question and receive an answer, or can give an answer and receive feedback. For example, in the course of learning, the learner can seek help from an on-screen agent or can click on a highlighted word in a hypertext environment to get additional information. Interactivity enables the learner to determine the pace and/or order of the learning episode. For example, with a narrated animation, the learner may be able to control the pace by using a pause/play key, or by using a continue (or
forward) button when the material is presented in segments; and the learner is able to control the order by using a forward and back key, rewind key, slider bar, or a menu for direct access to a particular segment. Interactivity that is manipulative allows the learner to control aspects of the presentation, such as setting parameters before a simulation runs, zooming in or out, or moving objects around the screen. Where interactivity is accomplished by searching, the learner is able to engage in information seeking by entering a query, receiving options, selecting an option, and so on, as in an Internet search. Interactivity that is based on navigation enables the learner to determine the content of a learning episode by selecting from various available sources, such as by clicking on a menu (Moreno & Mayer, 2007).

Learning from Web-Based Formative Assessment

Digital textbooks provide forms of online formative assessment tools within the digital textbook system as well as supplementary and in-depth learning materials for each level. Digital textbooks allow teachers to use evaluation data to assess whether study goals are achieved. Formative assessment refers to those activities that are used to help students learn (Clariana, 1997). A learning environment with formative assessment has numerous benefits for learners. Many studies have indicated that integrating the e-learning environment with Web-based assessment has positive results (Velan, Kumar, Dziegielewski, & Wakefield, 2002; Henly, 2003).

Zakrzewski and Bull (1999) found that online-format tests have at least three advantages for students. Students can take the assessment at any time, they can take it repeatedly, and it can provide instant feedback that helps remedy weaknesses in their learning abilities. They also have indicated that student anxiety can be reduced by taking a formative assessment before summative testing. An additional benefit of online assessment is that it can be adapted to student leaning styles (Clariana, 1997). Bransford, Brown, and Cocking (2000) suggested that the learning environment must include centralization in assessment. They further noted that formative assessment designs should be able to engage student attention and engender student commitment to self-evaluation, enhancing learning effectiveness. Buchanan (1998) further suggested that a Web-based formative assessment strategy is able to improve student learning interest and student scores. Digital textbooks can adopt online formative assessments with their widely recognized benefits for student learning.

Learning in Self-Regulated Learning Mechanism

Learning with a hypermedia environment in digital textbooks requires a student to regulate his or her learning; that is, to make decisions about what to learn, how much time to spend on it, how to access other instructional
materials, and to determine whether he or she understands the materials (Azevedo, 2005b; Azevedo & Cromley, 2004). Self-regulated learning (SRL) can be defined as learning that involves actively constructing an understanding of a topic/domain by using strategies and goals; regulating and monitoring certain aspects of cognition, behavior, and motivation; and modifying behavior to achieve a desired goal (Pintrich, 2000). Studies have found that students need to self-regulate their learning with hypermedia, including monitoring how much time to spend in different representations of information and when and how to modify strategies used in the hypermedia environment (Azevedo, 2005b; Shapiro, 1999; Williams, 1996).

Furthermore, other SRL processes related to planning, such as prior knowledge activation (Pintrich, 2000) and setting sub-goals, have been found to be related to learning challenging topics with hypermedia (Azevedo, Cromley, Winters, Moos, & Greene, 2005).

Digital Textbook versus Printed Textbook

South Korean educators have compared the characteristics of electronic and traditional texts. Digital textbooks and printed textbooks differ in many ways. The types of instructional materials that printed textbooks offer are limited to text and image-centered flat, linear learning materials. On the other hand, digital textbooks permit a range of multimedia learning materials like video and virtual reality. Further, digital textbooks benefit from easy conversion of data and can reflect new facts and knowledge quickly as compared to printed textbooks. Accessing data outside of a printed book requires much time and expense, while the hypertext function of the digital textbook can easily and quickly link to various educational materials or databases. Digital textbooks also allow for differentiated instruction, as students can switch between levels of difficulty. In addition, students can link to a variety of subject matter and, with the hypertext feature, there can be interaction among teachers, students, and computers. Various features of digital textbooks help create student-centered class activities and self-leading study (South Korean Educational Research Information System, 2010).

RESULTS: THE EFFECTIVENESS OF DIGITAL TEXTBOOKS

The effectiveness of digital textbooks has been examined by a number of researchers and by the South Korea Education and Research Information Service (KERIS). While several researchers found that digital textbooks produced positive effects, the KERIS research team found no statistically significant difference in learning between digital textbooks and printed textbooks. Uyn (2007) found significant improvement in students’ interest, comprehension,
satisfaction, and self-efficacy as well as in their level of academic achievement after using differentiated instruction with digital textbooks. Song, Jun, and Ryu (2007) found that the experimental group with digital textbooks showed higher levels of academic achievement than the control group with printed textbooks. Differences were apparent depending on socioeconomic levels. Students who resided in mid- and small-size cities showed significant differences in their level of academic achievement as compared with students who resided in bigger cities. There were no differences between the control and experimental groups whose fathers possessed bachelor’s degrees while there were differences between the control and experimental groups whose fathers earned a high school diploma (KERIS, 2008).

The research team of KERIS (KERIS, 2008) identified several advantages and positive unique features of using digital textbooks. First, the nature of instructional planning was altered. With conventional textbooks, teachers needed to spend considerable time preparing teaching props to increase students’ motivation to learn. However, because the digital textbook was already equipped with motivational material, teachers could spend more time designing and developing instructional strategies rather than just making materials. More importantly, by changing the nature of time spent on instructional planning, teachers could concentrate on providing more significant instructional feedback than simply checking homework. The interactive whiteboard also increased instructional flexibility as it allowed collaborative sharing of learning content with students.

Second, for the analysis of teachers’ transcripts for verbal function, cognitive strategies, and social process, it was difficult to come up with conclusions because it varies depending upon characteristics of subject matter and instructional setting. For cognitive strategies there were no prominent patterns by types of textbook. However, in mathematics there was more explanatory interaction with the digital textbook. Digital textbooks might be suitable with mathematics because they are good for presenting materials and for letting learners manipulate concepts (KERIS, 2008).

KERIS (2008) further conducted research on the effects of digital textbooks. Data were collected from 18 of the 20 schools designated as digital textbook laboratory schools by MEST. The study was conducted for seven months between May 15, 2008, and December 15, 2008. A total of 4,284 students from 24 schools participated. Academic achievement was selected as the primary independent variable to identify the effectiveness of the digital textbooks. Other variables were also measured in order to arrive at a better understanding of the effects of the digital textbooks. The additional variables were learning attitudes toward each subject area, problem-solving skills, self-regulated learning ability, and effects of digital textbooks. For academic achievement, they found that there was no educationally significant difference between the digital textbook groups and printed textbooks groups, while there was a significant difference between the urban school
students and the rural school students. The significant differences were found in different subject areas and among low-achieving students. Digital textbook students in urban areas had significantly higher mean scores in science, social studies, and South Korean compared to those of the printed textbook students. The digital textbook groups in the rural areas scored significantly higher than printed textbook groups in all subject areas.

Moreover, low-achieving students in the digital textbook groups scored significantly higher than the printed textbook groups in South Korean in both the urban and rural areas. Social science scores in the urban area and mathematics scores in rural areas were significant in the digital textbook group study (KERIS, 2008).

There was no educationally significant difference found in metacognition, self-regulated learning, self-efficacy, information exploration, problem-solving, intrinsic motivation, and self-reflection. However, there were significant differences between the rural students and the urban students in these variables. The research concluded that there was a potential to improve the academic achievement of low-achieving students. The article asserted that it is necessary to improve teachers’ capability through systematic trainings and understanding of the technological infrastructure in order to maximize the positive effects of the use of the digital textbook. They also pointed out that a longer research study, at least three years, would be necessary to improve the validity of the study (KERIS, 2008).

**LIMITATIONS OF DIGITAL TEXTBOOKS AND SUGGESTIONS FOR IMPROVEMENT**

The limitations of digital textbooks described in previous research (Kim, 2005; Son, Seo, Kim, & Kim, 2004; Byun, Ryu, Ryu, Choi, & Park, 2005) can be summarized as follows. First, because many features of e-learning were incorporated in the digital textbook, there were no clear boundaries between digital textbooks and instructional Web sites particularly as regards content and structure. Secondly, the parameters of the digital textbook were unrealistically comprehensive, which made it difficult to develop and maintain the digital textbook. An overwhelming number of additional features added time and budgetary constraints and made the textbooks difficult to maintain. Thirdly, digital textbooks tend not to provide the same kind of idiosyncratic contents and images as printed textbooks, so students still must refer to the printed textbooks. This was inconvenient. Fourth because there are few instructional and learning models for the use of digital textbooks, the role of the digital textbook in the classroom is still vague (Byun et al., 2006).

As the development of digital textbooks progressed, KERIS (2008) made three major suggestions for improvement. First, there needs to be a wider
variety of content development that should be more resilient to accommodate characteristics of different subject matter. Additionally, it is important to identify design strategies that support individual learner’s characteristics. For instance, simulations can be considered one of the beneficial design formats to help visual learners. This method also will strengthen self-regulatory learning. Second, there have yet to be developed instructional models and/or formats for small group collaboration using the digital textbook. While several instructional methods for collaborative learning have been applied in the classroom setting, these methods were designed and developed for use with conventional textbooks. Digital textbooks have very different functions and features that can have a great impact on collaborative group dynamics. If teachers try to use conventional collaborative strategies with the digital textbook, they may find success elusive. Third, there should be an emphasis on finding ways to create features/functions of digital textbooks that are aligned with the nature of a particular subject matter. For instance, science classes often require various laboratory activities; however, digital textbooks cannot support them. Furthermore, digital textbooks should support more manipulative and discovery activities.

Byun et al. (2006) argued that if the digital textbook is to function as a textbook, students should be able to own one and take it with them to the classroom or home. They asserted that the designer of a digital textbook should ensure the portability and usability of the digital textbook. In so doing, the digital textbook will be able to play a major role as a teaching and learning medium. In addition, while still in the design stages, attention should be given to the possibility that multimedia presentations may overload students’ cognitive capacity during learning (Baddeley, 1992). Further, provision of timely feedback from the experts should be included (Moreno & Valdez, 2005).

CONCLUSION

Using digital textbooks was an innovative project that was robustly planned, implemented, and researched with the support and supervision from the South Korean government. The major goals of using digital textbooks were: (a) to meet the needs of a paradigm shift in learning in accord with millennial learning styles, (b) to improve the comprehension and application skills of knowledge, (c) to produce equal opportunities for students regardless of their socioeconomic status, and (d) to reduce the cost of private tutoring. If these goals are met, digital textbooks will ultimately help cultivate human resources capable of competing in the global economy.

Digital textbooks allow students to learn content that is tailored to their abilities and interests. They also offer many advantages over paper-based textbooks: They are far less bulky, easier to update, and provide more
meaningful learning experiences with multimedia. Using digital textbooks opens more possibilities and challenges in education. The academic effectiveness of digital textbooks has not been proven (KERIS, 2008), even though Uyn (2007) found improvement in student interest, comprehension, satisfaction, and self-efficacy. A significant difference was also found between rural and urban students and low-achieving students (KERIS, 2008). Moreover, South Korean educators’ systematic approach to this cutting edge technology has been recognized by world educators (KERIS, 2007).

Before South Koreans transfer digital textbooks to the majority of schools in South Korea, they poured effort to establish the foundation, prototype, and teaching models by experimenting with laboratory schools, and identify expected challenges and shortcomings of digital textbooks. The current research launched with the understanding that it was important to provide enough time and infrastructure to support the use of digital textbooks in real-life classrooms (KERIS, 2007). The design and implementation of digital textbooks necessitate more experimentation and analysis of their effectiveness in the future in relation both to issues of cognitive overload with multimedia and to enhancement of self-regulated learning. To this end, the South Korean government recently extended their support for the digital textbook. The MEST is planning to spend $15.5 million to establish e-book infrastructures in 110 schools in rural communities around the country, where the digital transition is to be tested first (The South Korean Times, 2009). Because of the South Korean government’s ongoing effort to cultivate human resources and to develop systematic approaches, digital textbooks in South Korea will contribute to a new understanding of 21st-century education in South Korea as well as in the world.

REFERENCES


Moreno, R., & Valdez, F. (2005). Cognitive load and learning effects of having students organize pictures and words in multimedia environments: The role


