Analysis, design, and software shells to develop interactive e-textbooks

Aiym Sagdoldanova
University of International Business, Kazakhstan
aiym.sagdoldanova@gmail.com

Abstract

Goals and objectives of the research are to analyze operating digital platforms in Kazakhstan's education system and the models and tools for the development of electronic textbooks to integrate them with LMS.
As a research methodology it is used content analysis of scientific articles, academic sources, websites, online platforms and e-learning systems as well as ADDIE model for the development of electronic textbooks and their pedagogical design.
Results/Findings: different foreign and local educational digital platforms have analyzed as a research result. Also there were developed two types of electronic textbooks for 9th and 10th grade school students with Kotobee Author and iBook Author software, which can be also integrated with LMS and MOOC in further.
Novelty/Originality/Value of the study is the search for the most effective ways of applying digital technology in the learning process. The effectiveness of education primarily depends on digital educational content, including electronic textbooks. The article presents an analysis of the experience of developing school educational platforms in Kazakhstan and abroad to identify emerging trends and prospects for their development.
Theoretical research materials are used for analysis of scientific and pedagogical sources, synthesis, generalization and systematization. The practical significance is that materials and developed electronic textbooks can be used in schools as an additional supportive textbook for gaining in-depth knowledge.

Keywords: electronic textbook, e-learning, digital learning, digital platform, digital literacy

Introduction

The modern period of the development of society is characterized by a strong influence of computer technologies on it, which penetrate into all spheres of human activity. An integral and important part of these processes is the computerization and digitalization of education. The educational process is increasingly being transformed under the influence of new technologies in order to provide the skills and knowledge that will be in demand in the future in a rapidly changing market. The learning process is becoming more dynamic, there are no more boring lessons with monotonous delivery. Learning process is served in a game format. All this happens due to gamification, personalization and digitalization of content.

The introduction and use of the latest multimedia and information and communication technologies in the learning process is the most necessary aspect in the modern 21st century. Recently, it has been observed that the majority of the population quickly adapted to the use of advanced technologies in the field of education all around the world. Moreover people started to use iPad, tablets and devices for reading electronic books as personal digital devices (Chiu, 2017). All of this is forced for the development of e-learning and e-textbooks. As Belenkova (2016) emphasizes «At present, there is no unambiguous definition of the term electronic book. According to the first, electronic textbooks are an electronic course that contains a systematic presentation of the discipline or its section, part, corresponding to the state standard and the curriculum and officially approved as this type of publication. Others believe that an e-book is a computer, pedagogical software tool designed primarily for the presentation of new information, supplementing print media, serving for individual and individualized training and allowing to test the acquired knowledge and skills of a student to a limited extent. Third opinion, the electronic textbook is the main educational electronic publication created at a high scientific and methodological level, fully complying with the state educational standard of specialties and directions, determined by the didactic units of the standard and the program» (Belenkova, 2016, p.3).

The use of electronic books changes the main function of the teacher, turning him from a translator of educational information into an organizer of the process management of an effective learning manager. Traditional textbooks do not demonstrate the methods of

active development of the presented educational information. In addition to information, new electronic textbooks include technologies for organizing productive cognitive activities that are placed in their methodological part in the form of didactic blocks where basic educational information and methods of studying and deepening it are combined. When working with traditional textbooks, students receive ready-made information. An electronic textbook directs students to an independent educational search for self-control and self-assessment of knowledge (Belenkova, 2016, p.4).

Theoretical basis for electronic textbooks

The organization of effective e-learning involves providing students with both sources of information and necessary assistance. E-learning is implemented in a variety of forms: blogs, online discussion clubs, online games and simulations, online encyclopedias, online courses in the framework of Learning Management Systems (LMS), mass open online courses (MOOC), tablet apps, and more. A unified theory of e-learning does not yet exist. According to existing concepts the terms ***«cognitivism»*** and ***«constructivism»*** are widely used while creating and using e-learning tools (Janelli, 2018). Furthermore, behaviorism, the theory of digital media, and the theory of active learning are also used. Some scholars, however, argue that e-learning requires a new concept of learning.

Cognitive scientist Mödritscher (2006) believes that learning is an internal process in which thinking, memory, reflection, motivation and metacognition are involved. Information is perceived by different senses, processed by RAM, whose resources are limited, and then transferred to long-term memory that has no limits. Long-term memory organizes complex material into circuits, thus reducing the load on RAM and increasing its potential. The performance of RAM can be affected by both the essential characteristics of the processed material and external conditions. If too much material is supplied so that it cannot be processed by RAM and transferred to long-term, cognitive overload occurs. The problem is that many educational information technology and e-learning tools are more likely to increase than they are less likely to be cognitively overloaded (Burke, 2013). This is one of those problems that need to be addressed when cognitivism is used as a theoretical basis for developing e-learning options (Janelli, 2018).

The constructivist approach in e-learning assumes that students are involved in active and interactive activities that foster collaboration. It is assumed that, in carrying out constructivist tasks, students control their own learning process, in the format of discoveries controlled by the teacher or with the help of prompts on the screen, as a result of which the student makes the decision himself. Koohang et al. (2009) formulated three main components of a constructivist approach in e-learning: *activities* involving cooperation and the adoption of different points of view, the use of life examples, self-reflection, scaffolding, self-esteem and a variety of ways of representing ideas; *assessment*, including teacher assessment, group assessment and self-esteem; *teachers' functions*, including coaching, mentoring, recognizing students' efforts, providing feedback and student assessment. Subsequently, the authors expanded this model by identifying nine constructivist elements of e-learning, which included interdisciplinary training, self-reflection, the use of life examples and scaffolding to stimulate the zone of proximal development (Koohang et al., 2009).

There are three more theories that apply to e-learning, although much less frequently used rather than cognitive loading theory and constructivism. One of them is ***behaviorism***. Behaviorists consider learning in the context of external stimuli or environmental stimuli. Knowledge is acquired through experience and interaction with and around the world (Schunk, 2011). Behaviorists recommend that course designers structure their e-learning materials as follows: for example, all material should be broken down into smaller pieces or segmented tasks to facilitate understanding of complex information and activities. You can also use the behaviorist approach in the e-learning system in another way: to provide students with more opportunities to manage their own learning process, allowing them to choose the next step in the sequence of training actions (Mödritscher, 2006).

The next theory used in e-learning is ***Digital Media Theory***. This theory enriches e-learning with a variety of media formats that can be used for teaching and learning. The theory of digital media in relation to e-learning focuses on hardware, on technical means such as computers, mobile devices, recording devices, etc., rather than on software type or content of the training. In addition, the theory of digital media addresses important issues related to access to information and its accessibility, which are not fundamental for cognitivism and constructivism (Andrews, 2011).

Finally, the theory of activity and the theory of ***active learning*** are applicable to e-learning (Pange et al., 2011). Active learning is any educational strategy that involves students to be more active. The more active the student, the better he learns the material. One of the popular ways to increase student motivation, which is based on the theory of active learning is a gamification.

Analysis of digital platforms in Kazakhstan's education system and abroad

In connection with the development of information technologies in leading foreign countries where broadband Internet is developed, has been created national and regional educational networks to ensure access for teachers and students to the best educational resources. For example, in the UK, London Grid for Learning (LGfL) has been operating for almost 20 years. London learning network that provides broadband connectivity, network services, a common learning platform, online content and communication support for all 2600 public schools throughout London. Since 2007, a Norwegian digital learning arena (NDLA) has been operating in Norway, which is a government project aimed at ensuring free access to educational materials of guaranteed quality in all subjects in high school. Furthermore, in Singapore all public schools have access to the Singapore School Learning Space (SLS), an online platform that contains resources and learning tools that are aligned with the curriculum. The largest USA educational platform is Blackboard is used in every third USA school district, including 70 out of 100 largest districts, and serves more than 20 million students (Tazhigulova et al., 2019).

The state program «Digital Kazakhstan» which is scheduled for five years from 2018 to 2022 is needed to raise the level of digital literacy of the population and provide all schools with computers, multimedia equipment and broadband access to the network. The creation of electronic textbooks and educational sites, in particular will allow children who cannot attend schools to receive quality education due to the reasonable facts. For that reason as Batrakova (2019) mentioned electronic textbooks are an opportunity to study at the same time with classmates and keep up with the school curriculum for children with special educational needs or those children who have not temporarily attended school.

Nowadays, the following educational digital platforms operate in our country where everyone can access all school books in three languages: bilimland.kz, twig-bilim.kz, imektep.kz, opiq.kz, kitap.kz, openu.kz, academia.kz, budbeed.com, moocs.kz, etc.

Furthermore, the paper-free principle has been given a special place in the digitalization of education. It includes magazines and diaries from the «Kundelik» system, according to which teachers, parents and schoolchildren look at lesson schedules, homework and monitor performance.

Bilimland is a digital educational platform based on the cutting-edge achievements of world leaders in e-learning. This is the largest digital library of modern educational content, represented by a collection of 30 thousand electronic lessons, simulators, interactive exercises, educational videos and animated films, covering almost all subjects in Kazakh, Russian and English languages.

Bilim Media Group and British educational company Twig present a unique online training service ***twig-bilim.kz*** that has received worldwide recognition. An innovative platform, localized in 13 languages of the world, in more than 35 countries, has been recognized as the best learning resource at the BETT 2012-2013 and 2014 world educational technology exhibition. The complex consists of more than 1,500 fascinating short films, created on the basis of the school curriculum in chemistry, physics, biology, mathematics, geography and natural science. Each film is supported by additional materials in the form of illustrations, diagrams, tables and interactive test tasks.

imektep.kz is an online portal for controlling elementary school students. The portal allows quickly informing parents about the performance, attendance, homework of their children, view comments and notifications from teachers, and also create a centralized performance base for controlling state bodies. The author of School Electronic Control is the company Strategic Consultants & K. The system is implemented on the basis of industrial solutions of Microsoft Corporation.

OPIQ digital platform. According to statistics of 2015, Estonian children showed a very good breakthrough in the field of scientific and mathematical literacy all around the world. The main reason for this good result was the digital platform OPIQ textbooks. Inspired by the success of the Estonians, nowadays, in our country available a digital

platform opiq.kz on their technological base. Today, 75 textbooks in Russian and Kazakh are collected there. In addition, the textbooks of other publishers, such as ArmanPV and EduStream, which are engaged in the production of school textbooks like Almaty Baspasy, are already presented on the opiq.kz platform. Over the past three months statistics in March 2020, the active user base has doubled and is now approaching one million (Batrakova, 2019).

Methods of creating multimedia electronic books

Means of creating electronic textbooks can be divided into groups using a comprehensive criterion that includes indicators such as purpose and performed functions, technical requirements and application features. In accordance with the specified criterion, the following classification are widely used (Sun et al., 2017):

- high-level programming languages in combination with database technologies;
- multimedia tools;
- hypertext and hypermedia tools;
- special software for creating electronic textbooks.

Programming languages. Currently, most programmers use the languages HTML, PHP, JAVA, etc. to create an electronic textbook. HTML is a language for creating textbooks with hyperlinks and illustrations. It is possible to insert interactive demos created using Macromedia Flash, Java, and others. Advantages of the language: format universality, small amount of code, the ability to use under any operating system. Disadvantages of the language: functional limitation, lack of means of protecting information from theft and copying (Kazakov et al., 2015).

Also, Van et al. (2016) have mentioned other programming languages that are used to create ebooks. Ruby on Rails is an object-oriented software framework for creating WEB applications written in the Ruby programming language. Ruby on Rails provides an architectural model of Model - View - Controller for WEB-applications, and also provides their integration with WEB-server and database server.

Multimedia Tools. Multimedia technologies combine several ways of presenting information: text, images, animated images and sound into an interactive product.

Multimedia tools can significantly enrich the educational material by activating all methods of perception.

Hypertext and hypermedia tools. Hypertext is a method of nonlinear presentation of text material, in which the text contains in some way selected words that are associated with specific text fragments (Akimova et al., 2019). Thus, the user does not just leaf through the order of the page of text, he can deviate from the linear description by any link, that is, he controls the process of issuing information. In a hypermedia system, images can be used as fragments, and information can contain text, graphics, video clips and sound.

The use of hypertext technology satisfies such requirements for textbooks as structuredness, ease of use. If necessary, such a textbook can be published on the Internet and can be easily adjusted. Currently, there are many different hypertext formats such as HTML, DHTML, PHP, etc.

Special software for creating electronic textbooks. The creation and usage of intelligent educational platforms with a developed didactic interface helps to master the material in a deep and comprehensive way, and raise the professional training of students to the level of specialists. In the market of programs for creating electronic textbooks, there are both online and offline platforms that are available to everyone without knowledge of the programming languages. Table 1 illustrates requirements and comparative analysis for both offline and online based electronic textbook creator software.

Table 1. Comparative analysis of e-textbook developer software types

Software type	Price	OS type	E-textbook formats	Integration with LMS
Kotobee Author	Free +Full functionalities starts at $100	Windows, MacOS	Kindle, ePub, PDF, Word, SCROM, HTML 5	+
iBook Author	Free	MacOS	ePub, PDF, IBA	+
iSpring Suite	Available free version with limited toolboxes	Windows	pptx, HTML5	+

Adobe Captivate	Free with limited functionalities. Fully functional version starts at $399	Windows, MacOS	PDF, Mobi, ePub, Amazon Kindle	+
CourseLab	Offers a free trial, pricing starts at $199	Windows	PDF, .txt	+
Sqribble	Starts at $67	Windows	PDF, ePub, HTML5	-
Lectora Inspire	Starts at $1595	Windows, MacOS	SCROM, ePub, HTML5, PDF	+
Kitaboo	$99	Windows, MacOS	PDF, ePub, Mobi/KF8	+

Requirements for electronic books in education system

While developing electronic textbooks there occurs not only organizational and structural problems, but also design and technological problems which leads to developing requirements for all issues. For example, Burch and Good (2014) raise the serious question of the fact that in many cases the content of e-textbooks is determined by the developers and does not correspond to the curriculum. In addition, they note that publishers have little motivation to spend money on developing high-quality content, and that as a result, the content in many digital curricula is poor. Moreover, Hernes (2001) emphasizes the need for each country to develop local digital products, since foreign electronic educational programs and books can pose a threat to the national education system, culture and language. The main important point is that we have to emphasize that any resource has not only a teaching content, but also an educational effect: digital content should be educational and educational systems consciously set educational tasks that focus on traditional domestic spiritual and national values. Gu X. et al. (2015), Pepin et al. (2017) believe that e-content developers often focus on the interface or technical aspects, but there are relatively few studies that focus on pedagogical design issues, such as structure, content, etc.

Furthermore, the first design criterion for electronic textbooks is the content and volume of the training material. The content directly depends on the reader's address. To fulfill this criterion, it is necessary to revise the training material, leaving there the most key

and important points, additional information can be placed on the pages that can be opened according to the user's request.

Graphics, color, text, headings and the whole composition make up the information content of the page. The main percentage of information received by a person is perceived by sight. According to statistics, 83% of information is visually perceived and approximately 40% of it is remembered by a person. And the image can carry in itself no less, and sometimes even more information than text (Yakovlev et al., 2010).

There is also a spatial concept of perception of information. That which is closer (in the front side) is perceived earlier than that in the background. The background effect can be obtained with a fairly strong wash. An object with normal sharpness will appear to be in the foreground and be perceived first. Large and quite bright elements are also perceived before small, detailed ones.

Font design, like everything else, should be consistent. Mixed different headsets are not allowed. For electronic textbooks it is recommended to use the sans-serif font family (Yakovlev et al., 2010).

Findings

According to a social survey among schoolchildren and students of the city of Almaty aged 15 to 20 years, it turned out that 45% of the respondents prefer a paper version of the book. Many justified this choice in the usual way of reading, while others explained that they needed direct contact with a «live» book. 48% preferred the e-book, mainly students, substantiating their choice with the compactness of the device and the capabilities of fast reading. 7% of respondents preferred an audiobook, citing the convenience of listening on the road, public places, etc., as well as the amount of information that can be heard and received through audiobooks. Figure 1 illustrates the graphical result of this conducted social survey.

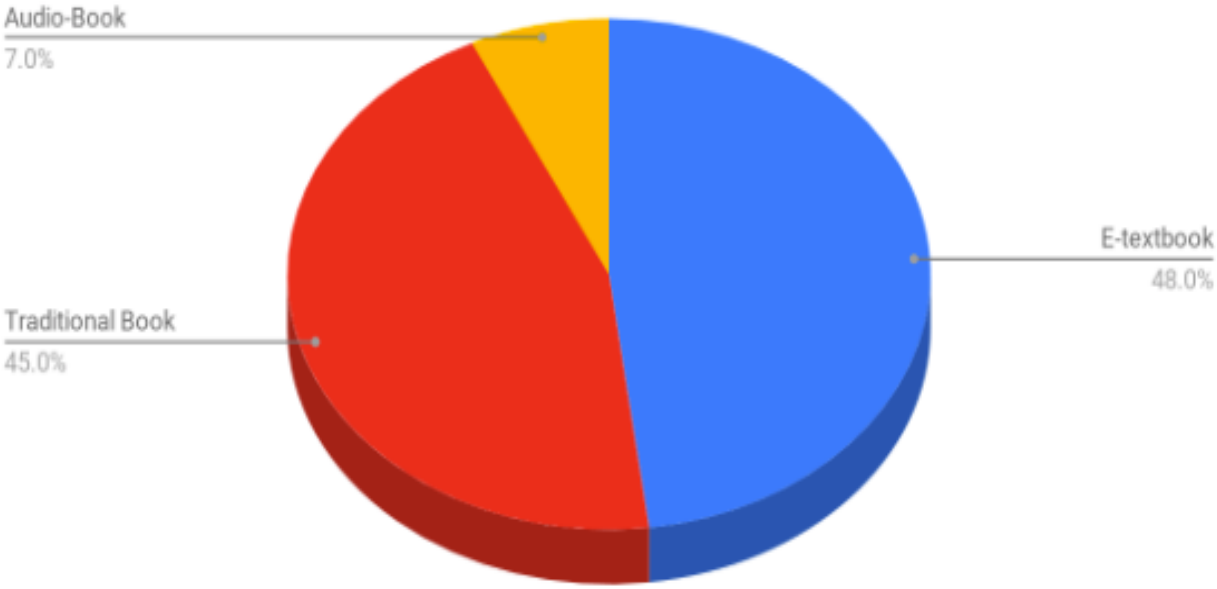

Figure 1. Book format preference chart

According to conducted survey among school teachers for the question «What e-book characteristics are important for you?» major part chose the renovated information.

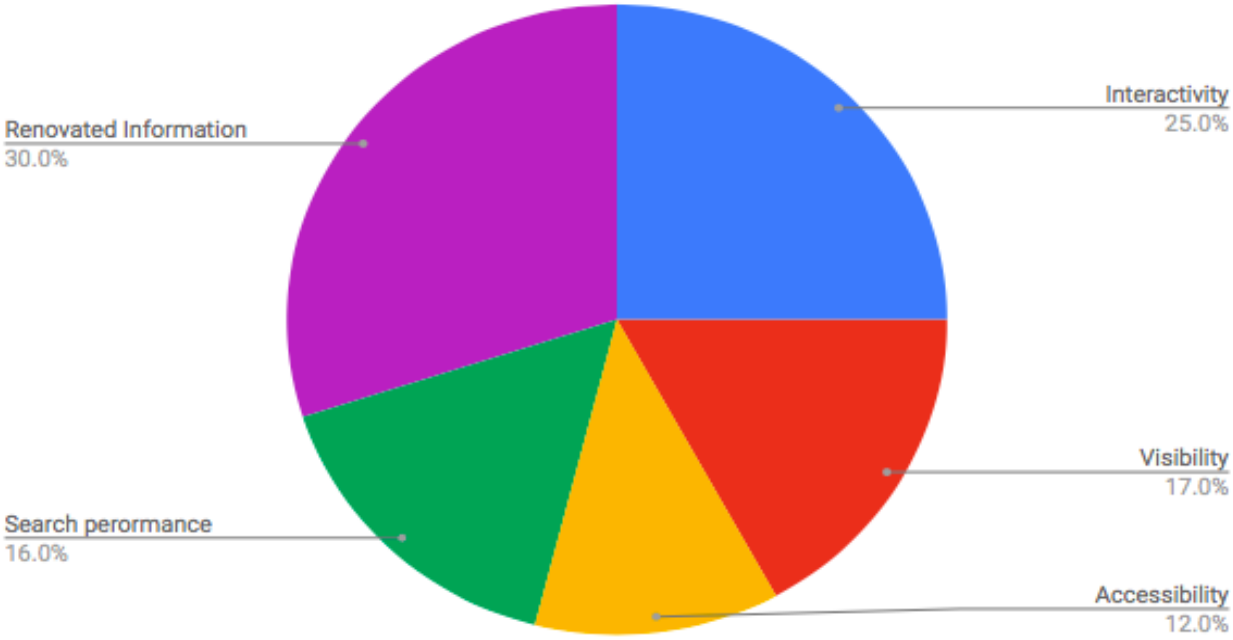

Figure 2. E-textbook characteristics

For the question «How well do you know e-book creator tools?» majority of them chose iSpring software, it is because iSpring available for everyone as an add-on for Microsoft Powerpoint.

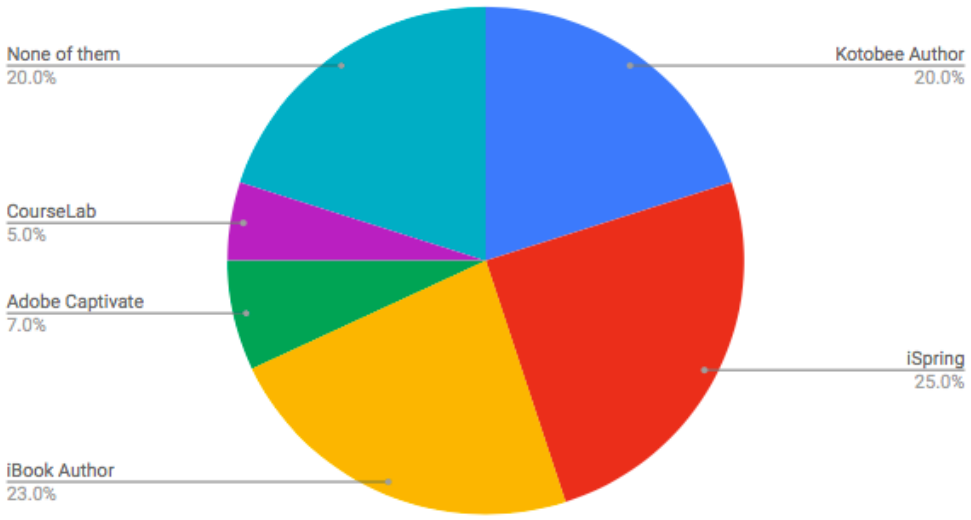

Figure 3. The popularity of e-textbook creator tools among teachers

Conclusions

The educational process is increasingly being transformed under the influence of new technologies in order to provide the skills and knowledge that will be in demand in the future in a rapidly changing market. The learning process is becoming more dynamic, there are no more boring lessons with monotonous delivery. Learning process is served in a game format. All this happens due to gamification, personalization and digitalization of content (Andrews, 2011).

As Tazhigulova et al. (2019) emphasized the usage of digital educational environment will contribute to the active implementation of innovative educational technologies, the mastery of scientific and technological knowledge and the fundamentals of creating an educational information environment for school teachers and students. Taking into account all these mentioned points this article covers various ways related to the design and development technology of an electronic textbook as a means of implementing effective learning activities.

The analysis of scientific and pedagogical literature and practice revealed that the trend in the development of digital educational content in Kazakhstan and abroad is sustainable, which corresponds to the challenges to educational systems from the digital economy. Abroad, there are prevailing trends in the development of e-learning systems that provide access to digital resources on specific topics, as well as open educational resources, massive open educational courses, tools for creating resources by consumers

themselves. At present, in Kazakhstan, products of Bilim Media Group such as bilimland.kz, imektep.kz, twig-bilim.kz and itest.kz are considered more effective.

In conclusion, online textbooks, a cloud-based learning system, virtual laboratories, a personal ID for each student, open educational content - all this awaits the education of Kazakhstan in the very near future. The digitalization that the country has embarked on is one of the leading trends in the process of reforming this sphere. Furthermore, digital educational resources will reduce the gap in the quality of education between rural and urban schools and ensure equal access to education.

References

Akimova, I.V., Gubanova, O.M., Leonova, T. Yu., & Titova, N.V. (2019). Special course "Technologies for creating electronic educational Aids" as a means of education for the development of electronic educational editions. *Modern problems of science and education, (4)*, 111-111.

Andrews, R. (2011). Does e-learning require a new theory of learning? Some initial thoughts. *Journal for educational research online, 3(1)*, 104-121.

Batrakova N. (2019) *Digitalization of education: are schools and children ready for e-learning?* Retrieved from https://informburo.kz/stati/cifrovizaciya-obrazovaniya-gotovy-li-shkoly-i-deti-k-obucheniyu-po-elektronnym-uchebnikam-.html

Belenkova, I.V. (2016). Technologies for the development of modern electronic textbooks and their use in the GEF. *Science and Prospects*, (3).

Burch, P., & Good, A. G. (2014). *Equal Scrutiny: Privatization and Accountability in Digital Education.* Harvard Education Press. 8 Story Street First Floor, Cambridge, MA 02138.

Burke, Lawrence. Educational and online technologies and the way we learn. *The International Schools Journal* 32.2 (2013): 57.

Chiu, T. K. (2017). Introducing electronic textbooks as daily-use technology in schools: A top-down adoption process. *British Journal of Educational Technology, 48(2)*, 524-537.

Digitalization in the school education system (2019, October). Retrieved from http://www.kisi.kz/index.php/ru/69-stati/nurgalieva-madina-maratovna/152

Gu, X., Wu, B., & Xu, X. (2015). Design, development, and learning in e-Textbooks: What we learned and where we are going. *Journal of Computers in Education,* 2(1), 25-41.

Janelli, M. (2018). E-learning in theory, practice, and research. *Education Issues, (4).*

Kazakov, A. Ya., Drozdova, E.N., & Savchuk, A. B. (2015). The technology for developing a software shell for creating electronic textbooks on mathematical subjects. *Computer tools in education, (3).*

Koohang, A., Riley, L., Smith, T., & Schreurs, J. (2009). E-learning and constructivism: From theory to application. *Interdisciplinary Journal of E-Learning and Learning Objects, 5(1),* 91-109.

Mödritscher, F. (2006). E-learning theories in practice: A comparison of three methods. *Journal of Universal Science and Technology of Learning, 28,* 3-18.

Pange, A., & Pange, J. (2011). Is e-learning based on learning theories. *A literature Review. World Academy of Science, Engineering and Technology, 56,* 62-66.

Schunk, D. H. (2012). *Learning theories an educational perspective sixth edition.* Pearson.

Sun, Y. T., Manabat, A. K., Chan, M. L., Chong, I., & Vu, K. P. L. (2017). Accessibility evaluation: manual development and tool selection for evaluating accessibility of E-textbooks. *In Advances in Neuro-ergonomics and Cognitive Engineering* (pp. 327-337). Springer, Cham.

Tazhigulova, A., Artykbayeva, Y., & Arystanova, A. (2019). Tendencies of development of electronic textbooks in Kazakhstan and abroad. *Bulletin of KazNU. Pedagogical Series, 59 (2),* 94-110.

Van Horne, S., Russell, J. E., & Schuh, K. L. (2016). The adoption of mark-up tools in an interactive e-textbook reader. *Educational Technology Research and Development, 64(3),* 407-433.

Yakovlev, B.S., Proskuryakov, N.E. & Cherevaty, R.S. (2010). Design features of electronic books. *Bulletin of Tula State University. Engineering, (2-2).*