Electronic Textbooks for Ukrainian Education: Statistics, Models of Development, Quality Problems

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ABSTRACT. The article provides the result of scientific research on developing electronic textbooks (e-textbooks) for Ukrainian schoolchildren. The aim of this empirical research was to compare e-textbooks development in 2018 and 2019, found out the major players in the Ukrainian e-textbook market for general secondary education institutions, the level of e-textbooks' provision in primary, middle and high schools, subjects that are most popular among Ukrainian e-textbooks publishers.

It was found out that the number of e-textbooks publishers has grown from 5 in 2018 to 9 in 2019, the largest number of e-textbooks for schoolchildren were developed for the 1st grade students (19 e-textbooks), the least number for the 11th grade students (2 e-textbooks). It was developed the most e-textbooks in the subjects "I explore the world" and "Mathematics" for the 1st grade (7 and 5 respectively).

The study identified and described two e-textbooks development models of Ukrainian publishers (outsourcing and standalone) and the platforms they used. An outsourcing model was used by 6 publishers, a standalone one used by 2 ones; 19 e-textbooks were produced using the first model; 27 e-textbooks were developed using the last one. Two of the publishers developed e-textbooks using both models. The most popular platforms for e-textbooks developing were the platform of the Multimedia Publishing House Rozumnyky (14 e-textbooks) and the mozaBook Editor program of the Hungarian company Mozaik Education (15 e-textbooks).

It was outlined some quality problems of developed e-textbooks and suggested the directions for further improvement of e-textbooks.

Keywords: electronic textbook, models of electronic textbooks, quality of electronic textbooks, requirement for electronic textbooks.

1   Introduction

The transition of Ukraine to the digital stage of development has led to the need to reform the educational sector, including the use of modern technologies for teaching. Nowadays, teachers are increasingly using electronic educational resources (EERs) in lessons to increase students' interest in learning, to optimize their learning time, to build an individual educational path, to explain or consolidate new learning material, or to test the generation that is born in the digital era with more efficient way.

The formation of the modern information and educational environment of an educational institution enables learning anywhere, anytime, stimulates the cognitive activity of students, automates the process of control over their educational achievements, promotes individualization of the learning process, etc. Essential components of such an environment are the EERs, including one of their varieties, namely an electronic textbook (e-textbook).

The definition of an e-textbook, the understanding of its role in educational process experienced significant changes over the last decade. While an e-textbook considered an electronic copy of a paper textbook ten years ago, now the electronic copy of a textbook (pdf version) and an e-textbook are clearly distinguished in Ukraine. There is an opinion that e-textbooks can only supplement print publications, but the Ministry of Education and Science of Ukraine plans to switch completely to electronic textbooks in schools over time.

The updating on the material and technical base of schools, the modernization of forms, methods and teaching aids, the development of a legal framework for the introduction of latest technologies in educational process are taking place in Ukraine nowadays. At the state level, some important documents have been adopted such as the Regulations on EERs, Distance Learning Regulations, Digital Economy and Society Concept for 2018-2020, Regulations on an e-textbook.

For the first time at the state level in Ukraine, the concept "electronic textbook" was introduced in the Regulations on electronic educational resources in 2012. Now this concept is also duplicated in the Law of Ukraine "On Education" and the Regulations on an e-textbook. All these documents state that "the electronic textbook (manual) is an electronic educational publication with a systematic presentation of educational material that is relevant to the educational program, contains digital objects of various formats and provides interactive interaction" [1, p. 4]. In our study, we understood the "e-textbook" exactly as it is defined at the state level.

Many scientists studied the implementation of e-textbooks in the system of Ukrainian vocational and higher education. The development of e-textbooks for vocational education institutions was studied by A. Guraluk, O. Didenko, H. Yelnikova, V. Lozovetska, P. Luzan, V. Shvets, V. Yurzhenko, L. Gumenna, A. Zueva, V. Lokshin, M. Rostocka, I. Shupik, who published "Guidelines for the development of an electronic textbook for vocational schools" in 2014 [2]. The technology of creating an interactive EER in the format of an e-book (notebook) to accompany a laboratory workshop on physics was explored by the authors who noted that it "combines interactive elements, visualization of processes, calculations, reporting, feedback with a teacher, and has a web page format suitable for viewing on different computers, using different browsers, with the possibility of uploading it to the Internet" [3, p. 265–266].

E-textbooks for general secondary education are less studied than other types of EERs. Ukrainian scholars mainly studied the EERs for schoolchildren (papers of V. Bykov, S. Lytvynova, O. Melnyk [4], et al). There are only few papers that are devoted to modern Ukrainian e-textbooks for schools. The articles of A. Antokhova [5], L. Iliichuk [6], S. Lytvynova [7], V. Kosyk, O. Melnyk [8], I. Vorotnykova [9], M. Zhenchenko [10] are worth mentioning here.

A. Antokhova [5] offered a comparative characteristic by different criteria (design, operating system, access conditions, types of tasks, etc.) of two e-textbooks for the 1st grade, namely "Art", developed by the Multimedia Publishing House Rozumnyky and "I explore the world", developed on the platform mozaWeb. L. Iliychuk [6] described the number of interactive tasks, interactive games, audio, video material in four e-textbooks for the 1st grade, namely "Art" and three e-textbooks from the integrated course "I explore the world" by different authors. S. Lytvynova [7] described and justified the use of Smart Kids technology and e-textbooks in elementary school educational process. She also analyzed the results of a survey of elementary school teachers conducted in 2018 regarding their attitude to the new type of textbooks. M. Zhenchenko [10] analyzed the editorial and publishing specifics of the e-textbooks for the 1st grade students developed in 2018.

The analysis of the scientific sources has shown that there is insufficient research on the development of Ukrainian e-textbooks for schoolchildren. This may be because the development of e-textbooks for Ukrainian schoolchildren is a new phenomenon and the active process of developing such e-textbooks in Ukraine began only two years ago. The impetus for this was the approval of the Regulations on an e-textbook in 2018 and the request of the state for their development in 2018 and 2019. The latter motivated publishers to develop 46 e-textbooks over the last two years. They have become the focus of our study. It was carried out within the framework of the research work "Development of information educational environment of a modern educational institution of Ukraine" (state registration number 0117U006234).

The study focuses on the analysis of e-textbooks for general secondary education institutions created in 2018 and 2019 by national developers at the request of the state over the last two years and submitted to the committees of the Scientific and Methodological Council of the Ministry of Education and Science of Ukraine.

The objective of this paper is to analyze the e-textbooks for Ukrainian schools developed by the Ukrainian publishing houses for:

- identifying major players in the Ukrainian e-textbook market for general secondary education institutions;
- study of e-textbooks' provision for primary, middle and high schools;
- determination and description of e-textbooks' development models used by the Ukrainian publishers;
- identification of the directions for further improvement of e-textbooks following the requirements of the international standard DSTU ISO/IEC TR 18120:2018. Information technology — Learning, education, and training — Requirements for e-textbooks in education (ISO/IEC TR 18120:2016, IDT) [11] that has been adopted in Ukraine recently.

All these steps will be able to improve the e-textbooks' quality, which will affect the effectiveness of digital education in Ukraine.

2 Research methodology

The study of electronic textbooks for Ukrainian schools was realized in several stages. At the first stage of the study, a bibliographic method was used to identify and systematize scientific sources, regulatory documents on the problems of e-textbooks' creation. The second stage involved the collection of empirical data on e-textbooks developed by Ukrainian publishers in 2018–2019. The third stage was dedicated to the processing data using methods of analysis, synthesis, summarizing and others.

The main sources of empirical data were e-textbooks developed by Ukrainian publishers in 2018–2019, presented on the website of the Institute for Educational Content Modernization. The number of e-textbooks developed during 2018–2019 is taken from the minutes of the meetings of the Commission on Informatization of Educational Institutions, prepared by the staff of the Digital Education and ICT Department of the Institute of Educational Content Modernization. The information on which e-textbooks have been evaluated and recommended for use in the educational process is obtained from the website of the Institute of Educational Content Modernization (the order of the Ministry of Education and Science of Ukraine № 1338 of 24.10.2019). Some informal interviews were conducted with publishers of e-textbooks and developers of platforms for e-textbooks in order to identify the specifics of e-textbooks development.

The collected empirical data were summarized and systematized using common scientific methods, such as analysis, synthesis, generalization, comparison, induction, and deduction. Mathematic methods were used to process the empirical data. Some graphic methods were applied for schemes, diagrams, and tables. The use of a simulation method enabled to offer e-textbooks development models to Ukrainian publishers. The descriptive method was useful at the stage of describing the research results.

3 Results and discussion

3.1 E-textbooks release statistics for 2018-2019 by publishers, grades and subjects

Developing of e-textbooks for schoolchildren in Ukraine is a new phenomenon that only began its development in 2018. Our study focuses on the analysis of e-textbooks for general secondary education institutions created by national developers at the request of the state over the last two years and submitted to the committees of the Scientific and Methodological Council of the Ministry of Education and Science of Ukraine.

According to the Ukrainian legislation, all e-textbooks have to be examined and considered by the relevant subject commissions and the technical one in order to obtain the permission for use in educational process, the approval of the Ministry of Education and Science of Ukraine. The subject commissions consider the content of e-textbooks for its compliance with the requirements for the content of e-textbook and the organization of educational material of e-textbook. The technical commission

examines the compliance of e-textbooks with design ergonomic, technical requirements, the quality of their functioning, etc. All requirements for e-textbooks are set out in the Regulations on an e-textbook.

Having reviewed the development of e-textbooks in Ukraine it can be said about the increase in interest of publishers to this issue. So, in 2018 only five Ukrainian publishing houses (Alaton, Geneza, Osvita, Orion, Ranok) developed thirteen e-textbooks for the 1st, 5th, 10th grades. Last year, nine publishers worked on the development of e-textbooks and produced another 33 new e-textbooks in different subjects for students of the 1st, 2nd, 5th, 6th, 10th and 11th grades (Fig. 1).
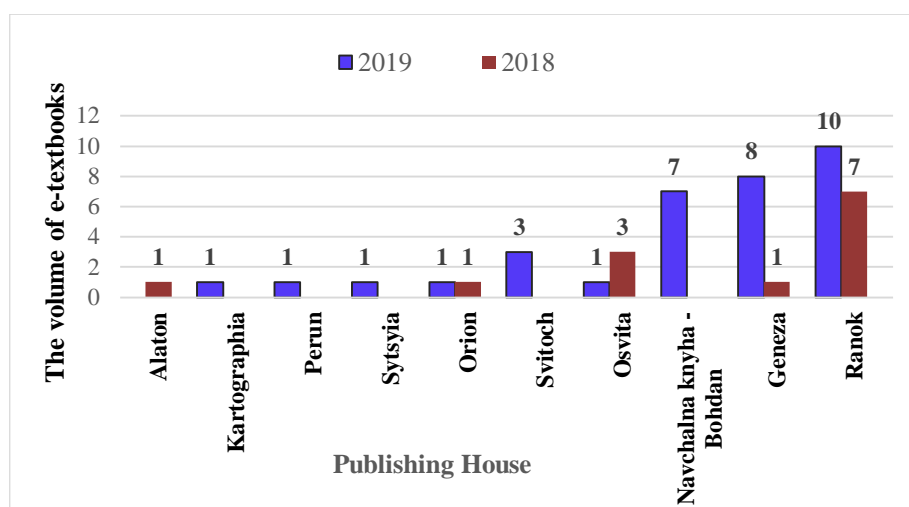

Fig. 1. Volume of e-textbooks, developed by Ukrainian publishers in 2018 and 2019.

The largest number of e-textbooks for schoolchildren was developed for the 1st grade students (19 e-textbooks), the e-textbooks for the 2nd grade were on the second place (8 e-textbooks), on the third place are e-textbooks for the 5th grade (7 e-textbooks) and 6th grade (7 e-textbooks), the last places were occupied by e-textbooks for students of the 10th (3 e-textbooks) and 11th (2 e-textbooks) grades (Fig. 2, Fig. 3).

The study showed that the publishers presented a wide selection of e-textbooks for primary school students in such subjects as "I explore the world" (7 e-textbooks) and "Mathematics" (5 e-textbooks) for the 1st grade, "Art" (8 e-textbooks) for the 1st and 2nd grades (Fig. 2).

Fewer e-textbooks, compared to primary school, were designed for middle and high school. The publishers offered 14 e-textbooks for middle school and only 5 e-textbooks for high school students (Fig. 3).
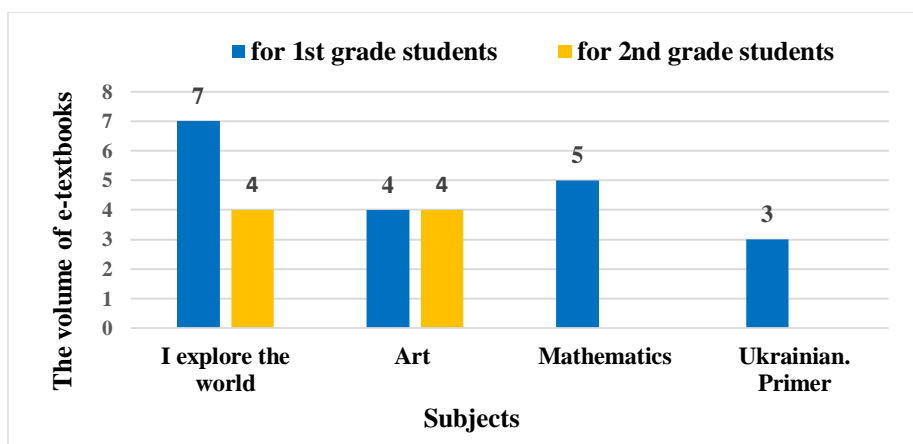
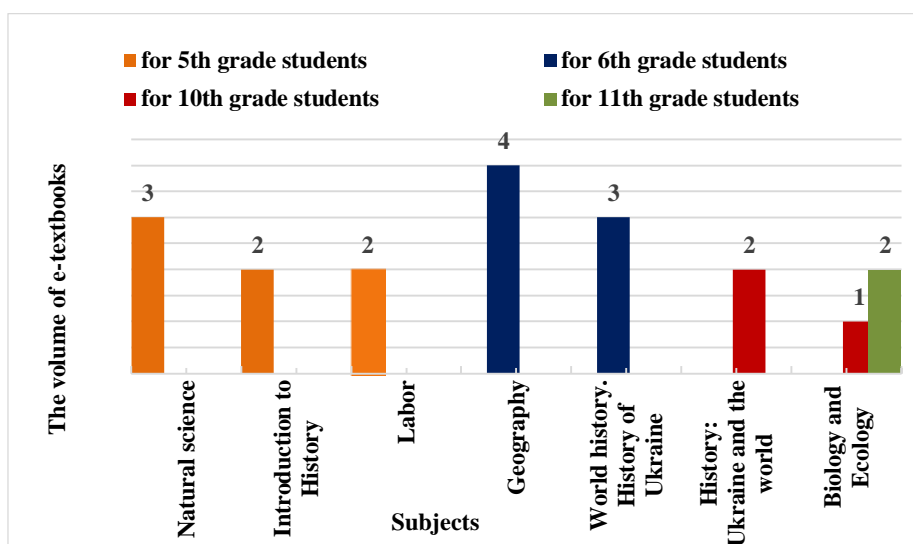**Fig. 2.** Number of e-textbooks for primary school by subjects and grades.

Fig. 3. Number of e-textbooks for middle and high school by subjects and grades.

3.2 Models of development of e-textbooks in Ukraine

According to the results of the survey conducted by M. Zhenchenko in 2018 on the trends in digital publishing (136 respondents), the executives of Ukrainian publishing houses indicated the lack of available software for creating interactive multimedia publications (15.5% of respondents) among the main problems hindering the development of digital publishing [12]. Because of this, the development of multimedia interactive publications is often the result of the convergence of publishing industry and IT technology sector. Software developers provide software engineers and

their experience in creating electronic products, and publishers provide content and understanding for the target audience [13, p. 300].

The study of publishing preparation technologies for 46 e-textbooks developed in 2018–2019 by Ukrainian publishers helped to clarify, and highlight the following trends:

▪ transfer of e-textbooks development features to other publishers or IT companies (**outsourcing model**);

▪ independent development of e-textbooks by publishers based on their own or third-party software (**standalone model**) (Fig. 4).
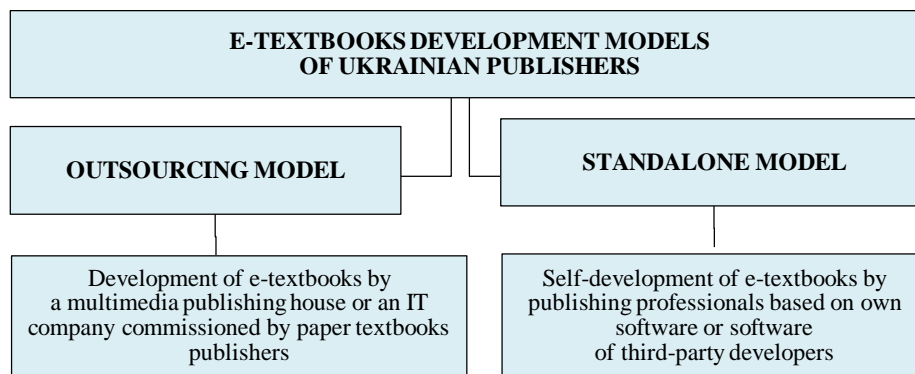
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┌─────────────────────────────────────────────────────┐
│         E-TEXTBOOKS DEVELOPMENT MODELS                │
│            OF UKRAINIAN PUBLISHERS                    │
└─────────────────────────────────────────────────────┘

┌──────────────────────────┐      ┌──────────────────────────┐
│    OUTSOURCING MODEL      │      │    STANDALONE MODEL       │
└──────────────────────────┘      └──────────────────────────┘

┌──────────────────────────┐      ┌──────────────────────────┐
│  Development of e-textbooks│     │  Self-development of e-textbooks│
│  by a multimedia publishing│     │  by publishing professionals    │
│  house or an IT company    │     │  based on own software or        │
│  commissioned by paper     │     │  software of third-party         │
│  textbooks publishers      │     │  developers                      │
└──────────────────────────┘      └──────────────────────────┘
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Fig. 4. E-textbooks development models using by Ukrainian publishers.

1. ***Outsourcing model.*** Some publishers developed their e-textbooks with the help of other multimedia publishing companies or IT companies using this model. For example, the e-textbooks of the Geneza Publishing House "Art" (1st and 2nd grades), "I explore the world" (1st grade), "Natural science" (5th grade), and "Geography" (6th grade) were developed with the help of

2. the Bristar Art Studio, which specializes in creating educational games that "cover different subjects and ages". The textbooks contain the full text of the paper version of the Geneza Publishing House textbooks but are complemented by interactive and multimedia content, as well as a mechanism for controlling knowledge of the topic being studied. Students have the option to download the versions for Windows and Android [10, p. 44].

The Rozumnyky Multimedia Publishing House has created the e-textbooks in which the drawings "come to life" and become animated, and the characters, voiced by professional actors, tell interesting stories. These e-textbooks based on the paper textbooks from the Alaton, Osvita, Orion, Perun, Ranok, Svitoch, Sytsyia publishers. The e-textbooks contain interactive tasks that facilitate the process of information assimilation. Each task in the publications is a mini-game on a topic that students learn. If a student completes the task correctly, an owlet will be hatched out an egg. The e-textbook program remembers the answers, and a teacher can see the results of the whole class in his e-journal [14]. The project team of a technology company or multimedia publishing company, which includes design artists, programmers, sound engineers and other specialists with non-publishing competencies, is working on the

creation of e-textbooks.

With this model of work, a paper textbook editor is a mediator between an authoring team, an expert and methodological circles, and a software development team. A publisher of paper textbooks may be a textbook consultant, but an IT company determines the objects of digitization on its own. The authors of the textbook are engaged in the creation of methodological support for interactive elements.

The Orion Publishing House collaborated with the Rozumnyky to create the e-textbooks "Introduction to History", "World history. History of Ukraine" (5th, 6th grades) on the principle mentioned above.

2. Standalone model. The publishers Navchalna knyha – Bohdan and Ranok have chosen to use the third-party software to create their e-textbooks.

The Publishing House Navchalna knyha — Bohdan developed e-textbooks using the iLesson system created by the Ternopil Multimedia Publishing House Soroka Biloboka. The system enables the development of multimedia applications that work on personal computers, tablets, smartphones, includes the ability to encrypt content, provide access through short serial numbers that can be sent via e-mail or SMS, send students' progress in a virtual classroom, view the results through free software on parent's and teacher's devices.

The Publishing House Ranok developed its e-textbooks in the mozaBook Editor program from Hungarian company Mozaik, which has been specializing in digital educational technologies for over 11 years. MozaBook lets you open PDF documents and creates e-textbooks based on printed textbooks with the help of a media library of the program that has over 1,200 interactive 3D models, hundreds of educational videos, a large number of audio files and interactive tasks. The mozaBook software, embedded applications, educational videos, interactive 3D models and their voices are available in lots of languages, including Ukrainian [15]. Note, that using the mozaBook does not mean an automatic transformation of a pdf file, ready for printing, into a digital multimedia textbook. According to the experts of the Publishing House Ranok, "the work volumes are enormous. Most of the content will have to be redesigned as it was designed for a print format. The texts of the printed books provided for interaction with a child without interactive tasks and equipment. That's why the first editors will work with literature and then technicians [16]. The head of e-books department of this publishing house Yevgeniya Kovaleva emphasizes that creation of an e-textbook also requires considerable efforts from authors, who have to think how to "integrate" various test tasks, games into a textbook, so as not to disrupt the general logic of presentation of educational material [16].

The Kartographia and Geneza developed the e-textbooks based on their software. The publisher Kartographia has created its own digital platform for learning anywhere, anytime, as students and teachers can access e-textbooks with animated illustrations, voices, testing from any digital devices and any time. The Publishing House Geneza developed the e-textbook "Mathematics" for the 1st grade and "I explore the world" for the 2nd grade by creating an enriched PDF file with built-in interactive and multimedia elements. This approach enables the development of e-textbooks in Adobe InDesign, which is traditionally used for printing paper textbooks.

The summarized data in Table 1 show that 19 from 46 e-textbooks were developed using an outsourcing model, 14 of them were developed by the Multimedia Publishing House Rozumnyky.

A standalone model was used to develop 27 e-textbooks, 14 of which were developed by the Publishing House Ranok using software of the Hungarian company Mozaik Education.

Some publishers (Geneza, Ranok) used different e-textbooks development models at the same time (Table 1), which demonstrates a search of optimal production models for e-textbooks publishers, effective software for e-textbooks development and a user-friendly technology platform.

Table 1. Use of different e-textbooks development models by Ukrainian publishers.

Publishing House	Number of e-textbooks	Platform developer	Model of development
Osvita	4		
Svitoch	3		
Orion	2	Multimedia Publishing House Rozumnyky	
Ranok	2		Outsourcing Model
Alaton	1		
Sytsyia	1		
Perun	1		
Geneza	5	Bristar Art Studio	
Ranok	15	MozaBook Editor program of the Hungarian company Mozaik Education	
Navchalna knyha – Bohdan	7	iLesson software from the Multimedia Publishing House Soroka Biloboka	Standalone Model
Geneza	4	Enriched pdf	
Kartographia	1	Own software	

3.3 Accordance of the quality of Ukrainian e-textbooks with the national and international standards

According to the Ukrainian legislation, all e-textbooks have to be examined and considered by the relevant subject commissions and the technical one to get the conclusion "Recommended by the Ministry of Education and Science of Ukraine", which gives the right to use the e-textbooks outside one educational institution. The subject commissions consider the content of e-textbooks and the organization of educational

material in e-textbooks, the technical commission examines the compliance of e-textbooks with design ergonomic, technical requirements and the quality of their functioning. All requirements for e-textbooks are set out in the Regulations on an e-textbook.

The important technical and functional requirements for e-textbooks are:
- the ability to "enable the operation of three or more operating systems, at least two of which are for mobile devices";
- the presence of "means of navigation by its structural units (eg, content, subject index, name index, etc.); tools for working with text, including the ability to take notes, bookmarks, highlight text, print selected pieces of training material in text or image format, the ability to search for keywords, as well as a dictionary (dictionaries); interactive elements";
- "balanced ratio of multimedia and other content" [1, p. 4].

However, not all 46 developed e-textbooks got the conclusion "Recommended by the Ministry of Education and Science of Ukraine", half of them did not pass the subject and/or technical commissions and was rejected because they don't meet requirements indicated in the Regulations on an e-textbook. Only 23 from 46 developed e-textbooks for schools got the commissions' conclusion "Recommended by the Ministry of Education and Science of Ukraine". None of 5 e-textbooks developed for high school passed the examination of the commissions (see Fig. 5).
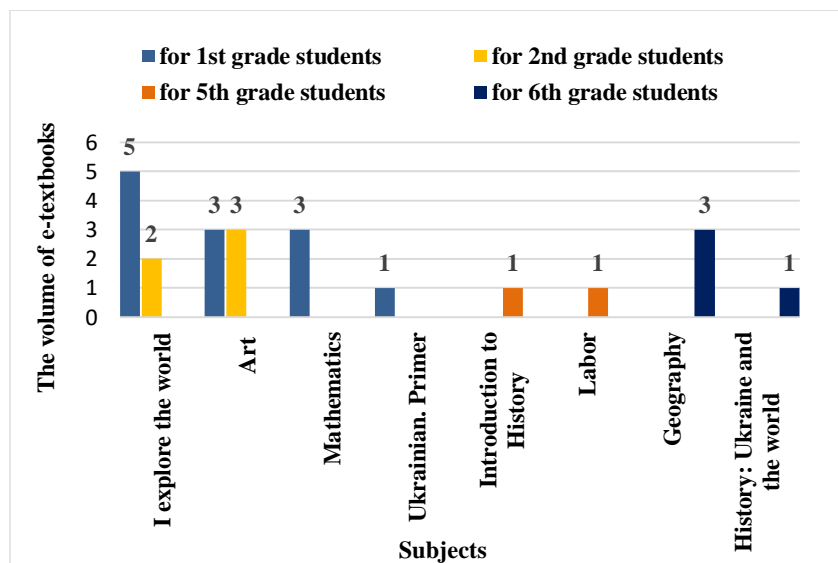

Fig. 5. Number of e-textbooks, which were approved for the use in schools.

It should be emphasized that the analyzed e-textbooks were developed on different technological platforms, there was no single unified format of e-textbooks, and most e-textbooks were designed as specialized programs for which a user needs to install additional software.

The international standard (ISO/IEC TR 18120:2018. Information technology — Learning, education, and training — Requirements for e-textbooks in education (ISO/IEC TR 18120:2016, IDT) adopted in the early 2020 in Ukraine states that "the standard provides for the need to define a common e-book format, preferably one that already has international recognition, which can be used as a basis for any specific educational specifications and standards that may be needed" [11, p. 6] and suggests that "the future standard of e-textbooks should be based on EPUB3 as the core standard, but allow extensions to handle alternative formats, if supported by certain practitioner communities" [11, p. 32]. HTML5 and XML are also mentioned as positive formats in different countries [11, p. 31].

Besides, the above standard provides an overview of pilot studies on the use of e-textbooks in different countries, the best practices of which should be taken into account in our country too.

Furthermore, the study identified some problems of developed in 2018 and 2019 e-textbooks for schoolchildren, such as their quality, absence of a single technological platform for their creation, as well as a single, acceptable for developers and users, e-textbook format, most e-textbooks require additional software.

The subject of previous research (A. Antokhova, L. Iliychuk, M. Zhenchenko) was only e-textbooks developed in 2018 for the 1st grade or justifying the use of Smart Kids technology and e-textbooks in educational process of elementary school (S. Lytvynova).

The problems of developing the e-textbooks publishers market, providing e-textbooks of various subjects and grades of secondary school, compliance of the e-textbooks' quality with the national and international standards were uninvestigated by scientists.

To solve the above problems there is a need to learn the experience of other countries in implementing e-textbooks to take into account the best practices; to conduct a thorough study of the impact of the use of e-textbooks on the level of students' educational achievements and concerning the role e-textbook in educational process; to define a clear e-textbook format adopted for developers and users; to create of accessible for Ukrainian publishers on the criterion "price-quality" technological platforms for the development of multimedia interactive e-textbooks that will meet the requirements of international standards and promote the development of blended and distant learning technologies. This will help to improve e-textbooks' quality and understand their role in the education process.

4   Conclusion

Ukraine is only making the first steps towards the digitization of education. The considerable attention has been paid to the development of the legal framework recently that is the background of such changes. This, in turn, encouraged developers to create e-textbooks that meet certain requirements and criteria adopted at the state level.

The study found that the number of publishers that started developing electronic content increased from 5 in 2018 to 9 in 2019. It was identified that major players in the Ukrainian e-textbooks market is the Publishing Houses Ranok, Geneza, Navchalna knyha — Bohdan (submitted in order of reducing the number of developed e-

textbooks).

It is also revealed that the number of e-books for Ukrainian students increased significantly over the last year. If only 13 of these textbooks were developed in 2018, their number increased by 33 in 2019. Most e-textbooks were developed for students of the 1st and 2nd grades (19 and 8 respectively); the least e-textbooks were designed for students of the 10th and 11th (3 and 2 respectively) grades.

A review of all e-textbooks developed for compliance with the requirements specified in the Regulations on an e-textbook revealed that only 23 e-textbooks were recommended by the Minister of Education and Science of Ukraine for the use in the educational process, all of which were refined over the last year and sometimes more than once.

The study on the issue of e-textbooks modeling by Ukrainian publishers found that there are two e-textbooks development models in Ukraine: 1) outsourcing, used by 6 publishers, and 2) standalone, used by 2 publishers; 19 e-textbooks were produced using the first model; 27 e-textbooks were developed using the last one. Two publishers have developed e-textbooks using both models.

Most publishers have used for their e-textbooks the platform of the Multimedia Publishing House Rozumnyky (14 e-textbooks) and the mozaBook Editor program of the Hungarian company Mozaik Education (15 e-textbooks).

In general, the analysis of 46 e-textbooks showed that despite the rapid development of e-textbooks in Ukraine, there are some problems with their quality, they are prepared through different technological platforms, there is no single technological platform, as well as a single, acceptable for developers and users, e-textbook format, most e-textbooks are designed as specialized programs that require additional software.

The following is suggested to solve the above problems:

1) learning the experience of other countries in implementing e-textbooks to take into account the best practices;

2) conducting a thorough study of the impact of the use of e-textbooks on the level of students' educational achievements. Such a study will determine at the state level what e-textbook for primary, middle and high school students should be: just a supplement for a paper textbook or alternative;

3) defining a clear e-textbook format adopted for developers and users;

4) creation of accessible for Ukrainian publishers on the criterion "price-quality" technological platforms for the development of multimedia interactive e-textbooks that will meet the requirements of the international standards and promote the development of distant and blended learning technologies;

The problem that requires further study in this area is developing a mechanism for the purchase of e-textbooks by the state.

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