

The Experience of Implementing a Digital Library in the Educational and Research Activities of the National Defense University of Ukraine Named after Ivan Cherniakhovskyi

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Abstract – Attention is focused on the relevance of the use of distance learning technology, in particular on the development, use and integration of a digital library with the modular object-oriented dynamic learning environment Moodle. The problem of development, integration and use of digital libraries, in particular the National Defence University of Ukraine named after Ivan Cherniakhovskyi (NDUU) digital library, is analyzed.

Keywords – distance learning, competence, implementation, digital library.

1. Problem Statement

Currently, the introduction of digital technology in the military education system, namely in the educational and research activities of a higher military educational institutions (HMEI) is a priority and relevant task reflected in numerous scientific sources [7], [11].

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Obviously, the prerequisite for this is an understanding of the need to improve the efficiency of educational and research activities of a HMEI through their digitalization, which will be reflected in the mobility of students and save their time on performing daily and routine tasks [10].

Moreover, the digitalization of a HMEI creates its unique educational and information environment, which on the one hand ensures elimination of conservatism in the educational and research activities of its participants, and on the other hand creates an innovative digital environment for subject-subject interaction of the teacher with the students. Accordingly, it facilitates to all participants in the educational and research process the achievement of a common goal of forming competitive and competent professionals for the Security and Defence Sector of Ukraine, which is essential in the face of countering the armed aggression of the Russian Federation.

It should be noted that currently the scientific and pedagogical staff of HMEIs creates for students with the help of digital technology a context-modeling environment for their future service activities in accordance with the tasks they will perform after acquiring relevant knowledge, skills and abilities, namely through the prism of the following: use of simulators for tank crews and pilots; conducting (cyber) CP exercises with the help of specialized software, etc. Considering this, there should be no questions about the role of digital technology in the training of future competent professionals for the Security and Defence Sector of Ukraine.

As a result, the demand of HMEIs for acquiring theoretical and practical experience in the implementation of various digital technologies that can be used in their educational and research activities is constantly growing. Thus, every year the NDUU holds an international scientific and practical

conference «Problems of implementing distance learning in the educational process of higher military educational institutions and possible ways to address them», attended by both military and civilian foreign researchers of higher education institutions. Accordingly, the leading issues to be discussed at the conference are the experience of implementing digital technology, in particular the introduction of distance learning methods in the educational and research activities of HMEIs. At the same time, the analysis of scientific publications shows that the current educational and research activities of HMEIs involves a variety of digital technologies and specialized software diverse in purpose, including the following:

- Moodle learning management system;
- BigBlueButton web conferencing system;
- H5P framework;
- Microsoft 365 cloud office suite;
- MODX content management system;
- DSpace digital repository and collective archives management tool;
- Eprints tool for building open access archives, etc.

Undoubtedly, the current trend of introducing digital technology in the educational and research activities of a HMEI is the Moodle learning management system, but no less important is the development and integration of a HMEI digital library into a single educational and information environment. Thus, practical experience shows that the specialized software DSpace and Eprints is mostly used to implement the digital library of a HMEI. They ensure storage, management and free access of HMEI students to digital resources in the form of articles, abstracts, monographs, dissertations, books, magazines, etc.

However, it is not possible to integrate them with the Moodle learning management system into a single learning and information environment. Moreover, in our opinion, DSpace and Eprints software tools are not quite efficient, flexible and interactive enough to be used as digital libraries of HMEIs. In addition, the more non-integrated software modules we have, the more there will be logins and passwords to access them, which will reduce the efficiency of their use as an elementary example of unbalanced integration of software applications intended for different purposes. Therefore, the problem of developing a digital library that would ensure its integration with the modular object-oriented dynamic learning environment Moodle and create a single learning and information environment is relevant.

2. Analysis of Recent Research and Publications

Analysis of scientific sources regarding various aspects of the creation and use of digital libraries in higher education institutions shows that research is conducted by both foreign and national scientists: T. Aalberg, F. Duchateau, M. Hall, T. Merccun and T. Risse [1]; R. Barbalace, T. Maharjan and M. Lotts [4]; A. Franca [6]; V. Gupta and L. Rubalcaba [8]; G. Kamau and A. Elegwa [9]; N. Li [12]; K. Owolabi, N. Okorie, O. Yemi-Peters, S. Oyetola, T. Bello and B. Oladokun [15]; M. Rafi, Z. Jian Ming and K. Ahmad [16]; C. Riehman-Murphy, A. Holloway and M. Mattson [17]; W. Shire and P. McKinney [18]; T. Singh and J. Singh [19].

But, despite the significant results of research and analysis of scientific sources on the creation and use of digital libraries in higher education institutions, it should be noted that none of them presented the experience in implementing such a digital library that would integrate it with the modular object-oriented dynamic learning environment Moodle and would create a single learning and information environment, which determines the relevance of the article.

The purpose of this paper is the presentation of practical experience in the development, integration and use of the digital library in educational and research activities of the NDUU.

3. Findings of the Study

Since 2020, the COVID-19 pandemic has had an unprecedented impact on all areas of human activities, including education and research at HMEIs. The NDUU, which is the leading HMEI of the Security and Defence Sector of Ukraine, was not immune to this influence. Accordingly, NDUU faced a challenge that required a rapid review (transformation) of its educational and research services and an accelerated transition to digital technology solutions within a short period of time. One of the most significant problems was how to arrange for NDUU students, research and teaching staff the stable remote access to educational and scientific resources, which were previously available only in traditional (printed) form and required their direct presence in the HMEI premises.

The analysis of technological solutions regarding the possibilities of transforming NDUU's educational and research activities into digital format showed that the best option for the transition to remote operation was the introduction of the modular object-oriented dynamic learning environment Moodle to NDUU's educational and research activities. Accordingly, Moodle supports the development, management and distribution of digital educational and research resources and ensures subject-subject interaction

between the teacher and students in the distance (online) format. In addition, the Moodle learning management system transforms traditional teaching methods into innovative ones, being the most popular open source learning management system [2].

As a result, many higher education institutions make effective use of learning management systems and conduct research on the efficiency of applying their different types. Thus, the results show that different learning management systems and their related digital tools increase students' motivation and educational-research interaction [5]. At the same time, they show the formation of functional productivity and critical thinking [3]. In the case of the NDUU, a dissertation study was also conducted [10] that confirmed the efficiency of the introduction and application of modern digital technology in the educational and research activities of HMEIs, which was based on the implementation of the Moodle learning management system. Thus, the implementation of the Moodle learning management system in educational and research activities made it possible to create an effective learning and information environment at the NDUU.

However, the experience of implementing the Moodle learning management system shows that it is not able to fully address all issues related to the educational and research activities of the NDUU regarding the formation of a single learning and information environment. Thus, on the one hand, the Moodle learning management system ensured the effectiveness of distance learning, and on the other hand, it showed the impossibility of creating a convenient (efficient) digital library, which is currently one of the key elements of a modern learning and information environment and a data repository for various types of scientific research.

Therefore, the problem arose of finding the ways to develop an own digital library of the NDUU that would be integrated with the modular object-oriented dynamic learning environment Moodle and would create a single learning and information environment. In addition, attention should be paid to the opinion of researchers Y. Li, K. Wang, Y. Xiao and J. E. Froyd [13] who emphasize the need for continuous improvement of the learning environment of a higher education institution, and we support this view.

It should be noted that libraries around the world are currently undergoing a digital transformation. Traditional libraries are being replaced by digital ones, while the new developed digital libraries are becoming increasingly more functional and technological. For the most part, a digital library is a complex information system, and the very concept of digital library is interpreted diversely by different researchers [14]. In our study, a digital library will be understood as a digital environment that is subject-

oriented, integrated, supports time chronology, and has a constant set of data and is a comprehensive source of reliable information.

Obviously, compared to traditional libraries, digital ones have the following advantages:

- time saving (users do not need to spend time on physical travel to the particular library location);
- mobility of access to digital resources (the use of network technologies allows the user to connect from any device, location and time);
- search automation, and etc. (a transaction request generates the necessary literature list in seconds compared to a physical search for the desired books).

Therefore, the introduction of a digital library is extremely important. However, there are also issues related to the immediate development, integration and use of digital libraries in higher education institutions, including the NDUU.

Therefore, we propose to consider these problematic issues on the example of the NDUU, which have arisen during the practical implementation of the digital library:

1. The Problem of Developing the Digital Library

The available digital technology ensures many technological solutions for the development of digital libraries, including popular specialized software tools such as: Dspace; EPrints; Fedora Commons; Koha; Greenstone, etc. However, the analysis of their capabilities shows, on the one hand, a powerful functionality, and on the other hand, an outdated and non-interactive web design that is not adapted to different types of devices, and outdated approaches to finding digital materials. It should be noted that when applying new technology, the user pays attention to the attractiveness of the interface, its adaptability, ease of use and other functional possibilities that from a psychological and pedagogical point of view should interest and motivate the user to apply the relevant software on a regular basis. However, in the absence of positive emotions from the use of the software, the user goes from a neutral emotional state to a state of rejecting the software, and this affects the user's learning accordingly.

Therefore, to develop a digital library, it is necessary to find the optimal software that would provide the opportunity to develop a friendly, interesting and easy-to-use interface of the future digital library. At the same time, this raises the question of the availability in the higher education institution of relevant highly qualified specialists in web programming, who would ensure an integrated approach to developing a high-quality and functional digital library.

2. The Problem of Integrating the Digital Library

Currently, few people analyze or at least pay attention to such an important aspect as the digital integration of various software applications. For example, during distance learning, users apply many different software tools, so they at least log in to their personal account in the Moodle learning management system, log in to personal mail (ukr.net or gmail.com), and log in to the library. Therefore, it is necessary to remember and store somewhere a large number of logins and passwords for each system, and the process of logging into each system takes time and increases cyber risks. Obviously, by integrating different systems, a synergy effect can be achieved. Accordingly, the synergy of different software application can occur at the level of data integration (combining data from different sources and providing data to users in a unified form), or web integration (combining disparate web applications and systems into a single environment based on network technology). Therefore, the problem of integrating the digital library with the modular object-oriented dynamic learning environment Moodle is relevant, which would allow to create a single learning and information environment. However, the solution to this problematic issue again depends on the availability of relevant highly qualified web programming specialists at the higher education institution.

3. The Problem of Using the Digital Library

Analysis of the implementation and use of various software in the educational and research activities of HMEIs shows that the research and pedagogical staff and students need time to master the relevant digital technology, including the development of their information and communication competence. Evidently, the HMEI should provide a permanent basis qualification upgrade programs for all subjects of educational and research activities to ensure that their professional development meets the challenges of the today's digital world.

Therefore, having analyzed the above, we can proceed to the description of the purpose, objectives and functional features of the NDUU's developed digital library.

The purpose of the NDUU's digital library is to provide information support of the NDUU educational and research activities and to ensure maximum integration with the modular object-oriented dynamic learning environment Moodle.

The tasks of the NDUU digital library are:

- accumulation and storage of fundamental and applied research in various fields of knowledge;
- understanding of information needs and assistance to HMEIs subjects in their educational and research activities;

- forming of conditions for the development of various professional areas of competence in the HMEIs subjects.

The functional features of the NDUU digital library are:

1. Development of a Digital Library Based on the MODX Content Management System

It should be noted that any digital library is based on modern web technology generally developed from scratch (as it requires a lot of time to program and determine the right technological solutions that will be used to implement the future digital library) or implemented through content management systems (which increases programming efficiency), namely: WordPress; Drupal; MODX and others.

It should be noted that any website or digital library is, above all, the content of web pages grouped in a certain way. All these pages are implemented in the form of menus, blocks and are graphically designed, which ensures convenience of organizing information on the site. Therefore, in order to increase the efficiency of programming and dissemination of this information (web content), a very effective specialized software tool Content Management System was created by global web programmers.

The Content Management System is a specialized software (site engine) used to create a website of varying complexity and properly manage its content. Given the experience of developing web portals (sites) and using different content management systems, it can be argued that the most rational choice for the development of a digital library is the MODX content management system.

MODX is an open source content management system. It is distributed under the GNU GPL (GNU General Public License). It is created with PHP (PHP: Hypertext Preprocessor) programming language and uses MySQL (Open-Source Relational Database Management System) for data storage. Moreover, MODX has integrated tools that expand its functionality, including:

- user registration system;
- built-in AJAX-based search;
- site menu generation system;
- comments publishing system;
- possibility to connect statistical and analytical modules;
- generation of catalogs, blogs, news, etc.

In addition, the advantages of MODX compared to other content management systems (WordPress, Drupal and others) are:

- easy scalability, the ability to create one's own program code in snippets, modules and plugins;

- modular development support: plugins, templates, chunks and snippets;
- full support for the XHTML specification;
- small size of the html-pages generated by the content management system as compared to its competitors;
- ease of programming in comparison with other competitors.

2. Modular Architectural Structure and Digital Library Integration with the Moodle Learning Management System

Therefore, the NDUU digital library was developed using the MODX content management system. In addition, its programming involved digital technologies such as MySQL; HTML; CSS; PHP; JavaScript and Ajax. Architecturally, the NDUU digital library consists of the following elements (functionally programmed tabs), such as:

- «Resources» (catalogs of all information content of the NDUU digital library, which is a set of web pages and its information materials) – Figure 1;

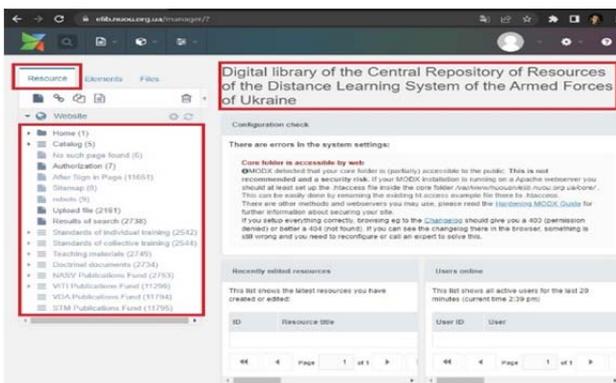


Figure 1. The «Resources» tab as an integral part of the architectural structure of a digital library in MODX

- «Elements» (a functional component of the digital library which contains all the programmed algorithm of its operation, namely templates for visual displaying of pages with added information materials, software variables and attributes of information materials, chunks of menus and functional search of information materials in the digital library, snippets of additional PHP code for the implementation of specific software functions in the digital library, plugins that expand the available functionality for more flexible programming of additional functions of the digital library, cataloging of code elements in accordance with the functions they perform) – Figure 2;

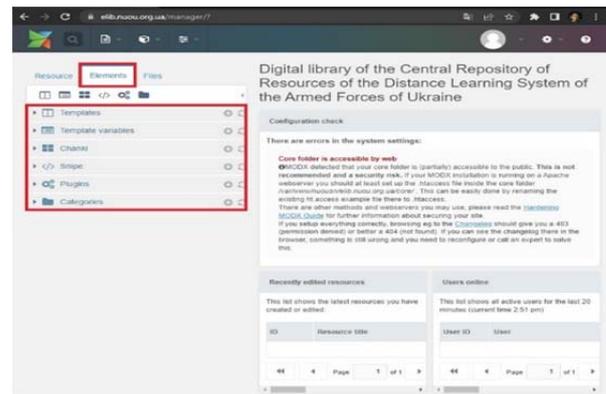


Figure 2. The «Elements» tab as an integral part of the architectural structure of a digital library in MODX

- «Files» (implementation of the FTP repository for uploading information materials to the digital library) – Figure 3.

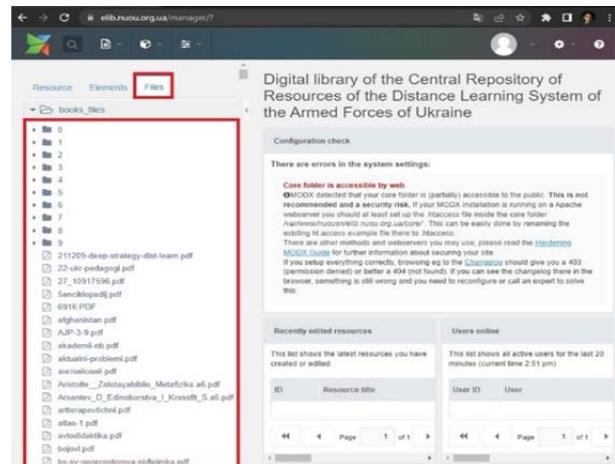


Figure 3. The «Files» tab as an integral part of the architectural structure of a digital library in MODX

Accordingly, the integration of the digital library with the Moodle learning management system was carried out using the programmed function of transferring the authorized user of the Moodle distance learning system to the NDUU digital library, namely:

- a user of the Moodle distance learning system logs in with the appropriate login and password (Figure 4);
- after authorizing in the Moodle distance learning system, the user lands on the system home page. Then the user can access the available distance learning courses or, in our case, go to the NDUU digital library using the button (link) «Digital library» (Figure 4);

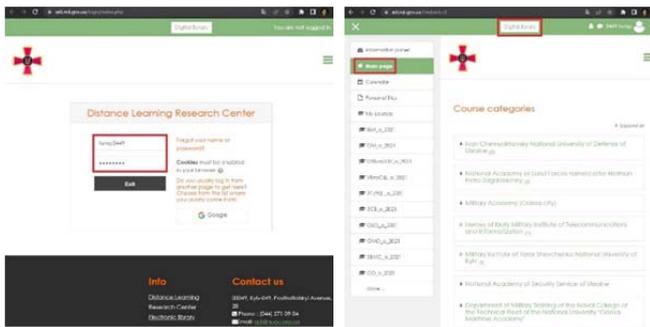


Figure 4. Authorization and transfer of the Moodle distance learning system user to the NDUU digital library

– following the «Digital library» link, the programmed function of transferring an authorized user from the Moodle distance learning system to the NDUU digital library checks and identifies whether the corresponding user belongs to the Moodle distance learning system (whether the user is registered in the Moodle system). Accordingly, if registration is confirmed, the digital library allows the user to work with its information materials within the limits of the granted access rights differentiation (Figure 5).

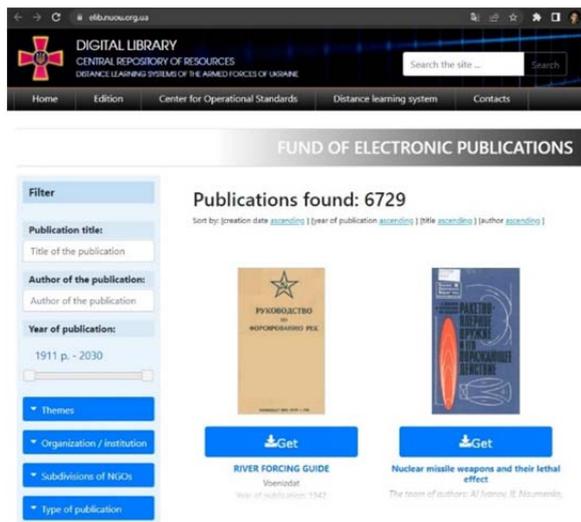


Figure 5. Home page of the NDUU digital library

Obviously, the implemented integration of the digital library with the Moodle learning management system increases the efficiency of access to it and reduces accumulation of login credentials pertaining to different systems. But unfortunately, given the approaches to cyber security and armed aggression of the Russian Federation against Ukraine, the authors cannot reveal in more detail the architectural construction and source code of integration of the NDUU digital library with the Moodle learning management system.

3. Adaptability of Design and Functionality of the Digital Library Filter

It should be emphasized that adaptive (interactive) design and quality (flexible) search using a filter is a decisive factor that affects the motivation and emotional satisfaction from using a digital library. Therefore, the

authors took into account relevant aspects in the development of the digital library. Thus, CSS (Cascading Style Sheets) was used to adapt the interface of the digital library, and all possible screen resolutions of modern digital devices (computers, laptops, mobile phones and tablets) were taken into account. Figure 6 shows representation of the digital library on the computer and phone, with an example of the deficiency of other libraries in terms of graphic design adaptability (Figure 7).

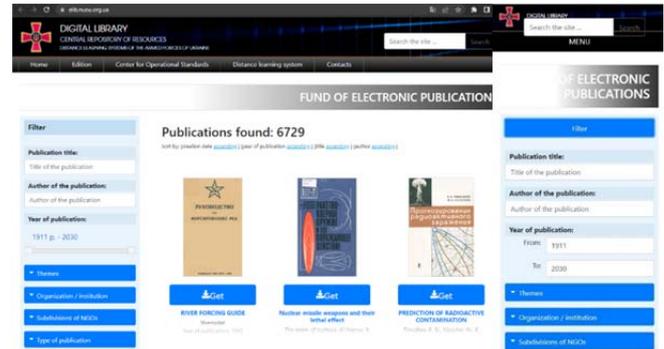


Figure 6. Representation of the adaptive (interactive) interface on different devices

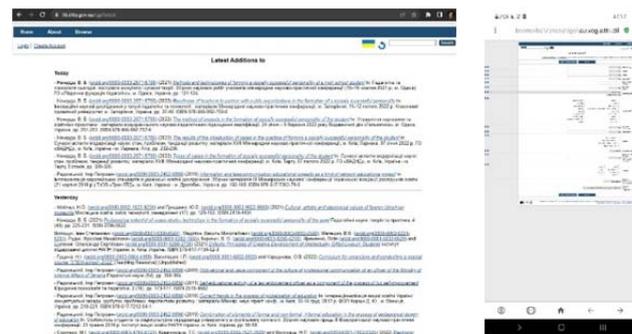


Figure 7. Representation of the drawbacks in the adaptability (interactivity) of the digital library interface of another educational institution

At the same time, attention should be drawn to the functional implementation of the search in the NDUU digital library using AJAX (Asynchronous JavaScript and XML) technology. The use of this technology in the development of the web interface ensures asynchronous data acquisition (in the background mode) when requesting the server. Therefore, when selecting the required parameters in the digital library search filter, the user instantly receives the necessary information without reloading the library web page. Looking at other digital libraries, one can see the use of outdated approaches to the implementation of the search for information materials, which might affect the ergonomics of its use in general.

In addition, the general options for search using the filter with the appropriate parameters in the NDUU digital library are: publication title; author of the publication; year of publication; themes;

organization/institution; subdivisions NDUU; type of publication; file format; city of publication; author's mark; UDC; ISBN; publisher.

4. Differentiation of the Rights of Access and Addition of Information Materials to the Digital Library

Given the potential impact of many factors on the cyber security of the NDUU digital library, the task of its cyber protection arises. One of the methods of cyber protection that can be used to address this problem is to differentiate the rights of users to access the information resources available therein. Thus, to address this problem, the authors used the ABAC (Attribute-Based Access Control) approach, which provides user access not in terms of the role and actions that the user intends to perform, but in terms of analyzing the rules for attributes, objects and possible access operations. Simply put, it is an Access Control List (ACL). Accordingly, ACL components are:

- principal (the object that receives access rights, a group of users in MODX);
- target (the object to which they apply, such as content or a resource group);
- access policy (the list of permissions obtained by this ACL);
- authority (the minimum level of authority required to use the ACL access control list).

Principal- In MODX, the principal is not the user as such, but the user group. For the access rights to function, the user should be added to this group. Moreover, the user can belong to several groups. MODX has 2 user groups: «Anonymous» and «Administrator». While the second group is self-explanatory, the first one is virtual. It serves only to determine access rights for guests.

Target- In MODX, access is restricted for five objects: content; resources group; elements category; media source and namespace. Note that all objects are single, while a whole group is used for resources. Thus, in MODX, access rights are assigned to a group of resources, not to a single resource. That is, by analogy with the file system, this means folders, not files. The same principle is used to configure the rights of access to MODX elements. Rights are defined not for a single chunk or snippet, but for the category of elements that groups them.

Access policy- It is united by a specific principle. For example, there is an «object» access policy for working with objects. It contains permissions to create, edit, delete, and view objects. All access policies can be found in the access control interface on the «Access Policies» tab, so it is possible to create there a new policy or copy an existing one and add the necessary rights to it.

Authority- This is the minimum level that allows the use of these policies. In MODX, it is synonymous with role. There is a certain perplexing feature that should be noted. The lower the number, the higher the level of authority. This non-intuitive fact just has to be remembered. MODX has 2 roles: «0» with the alias «Super User» and «9999» with the alias «Member». Thus, «0» corresponds to the maximum authority, «9999» – to the minimum. Roles can be created within these defined limits. In addition, when talking about a number, the concept of «rank» is used, and about an alias, the «role». Accordingly, the role of «Super User» has a rank of «0», while the role of «Member» has a rank of «9999».

Hence, adding information materials to the NDUU digital library and accessing it is possible only if the appropriate settings in the ACL are implemented. Therefore, if the necessary settings are made, a certain category of responsible persons of the structural units of the NDUU can add information materials to the digital library. In this case, the prerequisite for adding information materials by a user is to fill in the relevant data, such as: title; file; image; author; file type; publication type; publication developer; publication subject; publication year; author's mark; number of pages; UDC; ISBN; LBC; publication place; keywords; publication content. Figure 8 shows the result of adding and general representation of a specific publication in the NDUU digital library. In particular, all information about the publication entered by the responsible person during the addition of the information material to the digital library is displayed.

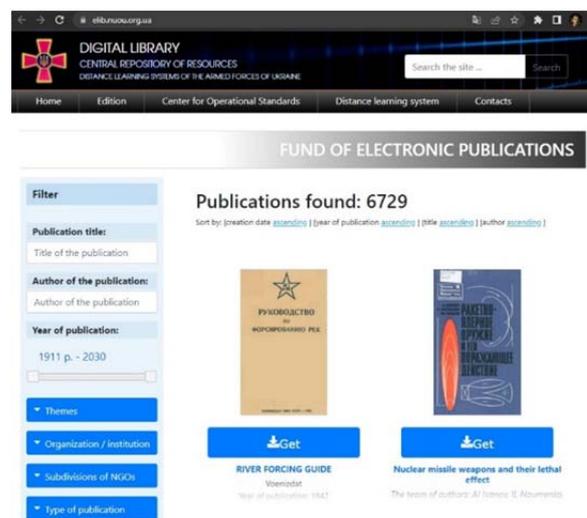


Figure 8. Representation of general information about a publication in the NDUU digital library

5. Metadata Indexing and Statistical Analysis of the Digital Library

The implemented digital library based on the MODX content management system allows indexing and retrieval of statistical and analytical information related

to its use and operation. However, in view of the specifics of the NDUU's educational and research activities, the management decided to restrict user access and prohibit the digital library indexing by Google robots. Therefore, only students and staff of the NDUU have access to the digital library.

6. Digital Library Updating

The possibility of updating the digital library is an extremely important aspect that determines the prospects of its efficient operation in the future. The authors' MODX-based implementation of the digital library allows to update its engine, which on the one hand improves the interface visible to the end user, and on the other hand shuts out the invisible yet existing cyber vulnerabilities through which hackers could perform cyber attacks and penetrate the digital system. Moreover, updating the digital library ensures the compatibility of its operation with different protocols, new versions of operating systems and browsers, which is an extremely

important aspect of the continuity of the process of educational and research activities of a HMEI. At the same time, the argument «there is no point in updates» may indicate low digital literacy of both the head of the higher education institution and the user who expresses it.

In addition, as part of the evaluation of the quality of educational and research activities of NDUU, a survey (questionnaire) of its participants involving 2123 respondents (Table 1) was conducted during November-December 2021 to determine the impression (various aspects) of using the NDUU digital library. Quantitative and qualitative characteristics of the respondents give grounds to claim that the sample population was representative for the survey. The survey consisted of 12 questions to be answered by respondents. The survey results are presented in Tables 1-12.

Table 1. The composition of respondents to the survey on the experience of using the NDUU digital library

№	Respondent's status	Quantity of respondents	Percentage ratio, %
1	Students	1,253	59
2	Cadets	36	2
3	Attendees	408	19
4	Adjuncts or doctoral students	106	5
5	Research staff	217	10
6	Research and teaching staff	103	5
Total		2,123	100

Thus, 2123 respondents took part in the survey on the experience of implementing a digital library in the NDUU, of which there were: 1253 students (59%); 36 cadets (2%); 408 attendees (19%); 106

adjuncts or doctoral students (5%); 217 research staff members (10%); 103 research and teaching staff members (5%). Accordingly, the data indicate the composition of the respondents.

Table 2. Awareness of respondents about the functioning of the NDUU digital library

№	Respondent's status	Quantity of respondents	Yes		No	
			persons	%	persons	%
1	Students	1,253	1,253	100	0	0
2	Cadets	36	36	100	0	0
3	Attendees	408	408	100	0	0
4	Adjuncts or doctoral students	106	106	100	0	0
5	Research staff	217	217	100	0	0
6	Research and teaching staff	103	103	100	0	0
Total		2,123	100	100	0	0

Accordingly, Table 2 presents data indicating 100% awareness of the functioning of the NDUU digital library.

Table 3. Ways of informing respondents about the functioning of the NDUU digital library

Ways of informing	Students		Cadets		Attendees		Adjuncts / doctoral students		Research staff		Research and teaching staff	
	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%
At the teaching and learning meeting before the start of the new academic year	1253	100	36	100	408	100	106	100	217	100	103	100
During informing by research and research and pedagogical staff during learning sessions	0	0	0	0	0	0	0	0	0	0	0	0
From a fellow student or officer	0	0	0	0	0	0	0	0	0	0	0	0
Self-inquiry about the availability of a digital library	0	0	0	0	0	0	0	0	0	0	0	0
Total	1253	100	36	100	408	100	106	100	217	100	103	100

Therefore, the results of the data in Table 3 show that all 100% of surveyed respondents were informed about the functioning of the NDUU digital library at the teaching and learning meeting before the new academic year. It should be noted that the NDUU has

a well-established system of entry of students into the new academic year, which certifies its efficiency in accordance with the survey data in Table 3.

Table 4. Determining of the library used by the NDUU respondents

№	Respondent's status	Quantity of respondents	Traditional		Digital		I do not use libraries at all	
			persons	%	persons	%	persons	%
1	Students	1253	291	23	962	77	0	0
2	Cadets	36	0	0	36	100	0	0
3	Attendees	408	51	13	357	88	0	0
4	Adjuncts or doctoral students	106	21	20	85	80	0	0
5	Research staff	217	24	11	193	89	0	0
6	Research and teaching staff	103	18	17	85	83	0	0
	Total	2123	405	14	1718	86	0	0

Table 4 shows that only 405 respondents (14%) use a traditional library, while 1718 respondents (86%) use a digital library, respectively. This

confirms that the NDUU digital library is a necessary digital tool that is relevant among the HMEI staff.

Table 5. The purpose of using the digital library by the NDUU respondents

Purpose of using	Students		Cadets		Attendees		Adjuncts / doctoral students		Research staff		Research and teaching staff	
	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%
Educational and research activities	937	75	18	50	366	90	3	3	187	86	79	77
Search for the latest received research materials	104	8	10	28	32	8	99	93	21	10	23	22
Self-education	212	17	8	22	10	2	4	4	9	4	1	1
I have not found anything interesting for me while using it	0	0	0	0	0	0	0	0	0	0	0	0

Thus, the analysis of the obtained results shows (Table 5) that 1590 respondents (63%) of the NDUU use the digital library for educational and research activities, 289 respondents (28%) – to search for the

latest received research material, and 244 respondents (8%) – for self-education purpose. Obviously, the NDUU digital library is achieving its goal.

Table 6. Frequency of using the NDUU digital library by the respondents

Frequency of using	Students		Cadets		Attendees		Adjuncts / doctoral students		Research staff		Research and teaching staff	
	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%
Every day	142	11	36	100	342	84	0	0	0	0	0	0
Once a week	176	14	0	0	25	6	88	83	155	71	99	96
Once a month	284	23	0	0	33	8	18	17	57	26	4	4
Twice a month	617	49	0	0	8	2	0	0	5	2	0	0
Once a year	34	3	0	0	0	0	0	0	0	0	0	0
Do not use	0	0	0	0	0	0	0	0	0	0	0	0

Accordingly, the analysis of the obtained results shows (Table 6) that 520 respondents (33%) of the NDUU use the digital library every day, 543 respondents (45%) once a week, 396 respondents (13%) once a month, 630 respondents (9%) twice a month, 34 respondents (0.45%) once a year, with no respondents who do not use the digital library at all.

Table 7. Respondents' evaluation of the functional interactivity of the NDUU digital library interface

Functional interactivity of the interface	Students		Cadets		Attendees		Adjuncts / doctoral students		Research staff		Research and teaching staff	
	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%
Very convenient	977	78	36	100	385	94	89	84	158	73	100	97
Convenient	276	22	0	0	23	6	17	16	59	27	3	3
Inconvenient	0	0	0	0	0	0	0	0	0	0	0	0
Very inconvenient	0	0	0	0	0	0	0	0	0	0	0	0

Thus, the analysis of the obtained results shows (Table 7) that 1745 respondents of the NDUU (88%) said that the functional interactivity of the digital library interface was very convenient, while 378 respondents (12%) stated it was convenient. Accordingly, there were none who said that the functional interactivity of the digital library interface was inconvenient or very inconvenient.

Table 8. Respondents' evaluation of adaptability of the NDUU digital library interface

Adaptability of the interface	Students		Cadets		Attendees		Adjuncts / doctoral students		Research staff		Research and teaching staff	
	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%
Very convenient	1253	100	36	100	408	100	106	100	217	100	103	100
Convenient		0	0	0	0	0	0	0	0	0	0	0
Inconvenient	0	0	0	0	0	0	0	0	0	0	0	0
Very inconvenient	0	0	0	0	0	0	0	0	0	0	0	0

Thus, the analysis of the obtained results shows (Table 8) that 2123 respondents (100%) of the NDUU emphasize that the adaptive interface of the NDUU digital library is very convenient.

Table 9. Respondents' evaluation of functional integration of the NDUU digital library with the Moodle learning management system

Adaptability of the interface	Students		Cadets		Attendees		Adjuncts / doctoral students		Research staff		Research and teaching staff	
	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%
Very convenient	1253	100	36	100	408	100	106	100	217	100	103	100
Convenient		0	0	0	0	0	0	0	0	0	0	0
Inconvenient	0	0	0	0	0	0	0	0	0	0	0	0
Very inconvenient	0	0	0	0	0	0	0	0	0	0	0	0

Therefore, the analysis of the obtained results shows (Table 9) that 100% of the NDUU respondents emphasized the very convenient integration of the digital library with the Moodle learning management system.

Table 10. Respondents' evaluation of the implementation of the search for information materials in the NDUU digital library

Search for information materials	Students		Cadets		Attendees		Adjuncts / doctoral students		Research staff		Research and teaching staff	
	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%
Very convenient	1253	100	36	100	408	100	106	100	217	100	103	100
Convenient	0	0	0	0	0	0	0	0	0	0	0	0
Inconvenient	0	0	0	0	0	0	0	0	0	0	0	0
Very inconvenient	0	0	0	0	0	0	0	0	0	0	0	0

Thus, the analysis of the results obtained from Table 10 shows that 100% of the NDUU respondents were satisfied with the implementation of the search for information materials in the digital library and described it as very convenient.

Table 11. Respondents' evaluation of the available information collection of the NDUU digital library

Information collection	Students		Cadets		Attendees		Adjuncts / doctoral students		Research staff		Research and teaching staff	
	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%
Satisfactory	1059	85	25	69	344	84	99	93	201	93	103	100
Partially satisfactory	194	15	11	31	64	16	7	7	16	7	0	0
Unsatisfactory	0	0	0	0	0	0	0	0	0	0	0	0

The analysis of Table 11 shows that 1831 respondents (87%) were satisfied and 292 respondents (13%) were partially satisfied with the available information collection of the NDUU digital library.

Table 12. Respondents' evaluation of the general impression of using the NDUU digital library

The general impression of using	Students		Cadets		Attendees		Adjuncts / doctoral students		Research staff		Research and teaching staff	
	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%	per-sons	%
Very impressed by the digital library	900	72	36	100	370	91	102	96	217	100	103	100
Satisfied by the digital library	240	19	0	0	25	6	4	4	0	0	0	0
Thought that it would be worse	113	9	0	0	13	3	0	0	0	0	0	0
Relatively normal	0	0	0	0	0	0	0	0	0	0	0	0
The quality does not meet my requirements	0	0	0	0	0	0	0	0	0	0	0	0
Very bad	0	0	0	0	0	0	0	0	0	0	0	0

Thus, the results of the respondents' survey on the general impression regarding the use of the NDUU digital library show the following (Table 12): 1728 respondents (93%) were very impressed by using the digital library; 269 respondents (5%) said they were satisfied with the digital library; 126 respondents (2%) stressed that they thought it would be worse.

Accordingly, there were none who said that the use of the digital library was relatively normal, the quality did not meet their requirements, or they had very bad impression. Thus, the conducted survey of NDUU respondents on various aspects of using the digital library confirms the appropriateness of the time, resources and effort spent on its implementation.

4. Conclusion

Thus, the COVID-19 pandemic since 2020 and the armed aggression of the Russian Federation against Ukraine proved the relevance of the transformation of educational and research activities of HMEIs, including the NDUU. Moreover, the analysis of possible ways to transform the educational and research activities of the NDUU confirmed the need to implement the Moodle learning management system which provided significant advantages over traditional learning. At the same time, the experience of using the Moodle learning management system has shown the ineffectiveness of its use as a digital library, and the issue of providing the NDUU students and other library users with constant access to digital resources which were previously available only in print, was becoming increasingly urgent.

Thus, the introduction of a digital library at the NDUU based on open source MODX software and its integration with the modular object-oriented dynamic learning environment Moodle confirmed its efficiency, which generally facilitated for all participants of educational and research activities the achievement of a common goal to form competitive and competent professionals for the Security and Defense Sector of Ukraine.

In addition, the survey of participants of educational and research activities of the NDUU showed that more than 93% of respondents were very impressed by the use of the digital library, which confirms the feasibility and purpose of the implemented NDUU digital library.

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