Digitalization of thesis preparation life cycle: a case of Zhytomyr Polytechnic State University

Andrii V. Morozov[1], Tetiana A. Vakaliuk[1,2,3,4], Igor A. Tolstoy[1], Yurii O. Kubrak[1] and Mykhailo G. Medvediev[5]

[1]*Zhytomyr Polytechnic State University, 103 Chudnivsyka Str., Zhytomyr, 10005, Ukraine*

[2]*Institute for Digitalisation of Education of the NAES of Ukraine, 9 M. Berlynskoho Str., Kyiv, 04060, Ukraine*

[3]*Kryvyi Rih State Pedagogical University, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine*

[4]*Academy of Cognitive and Natural Sciences, 54 Gagarin Ave., Kryvyi Rih, 50086, Ukraine*

[5]*ADA University, School of Information Technologies and Engineering, Baku, AZ1008, Azerbaijan*

Abstract
The situation in which Ukraine has found itself since February 2022 has also contributed to the development of digitalization of all processes in higher education. Thus, higher education institutions have such forms of control as course design, diploma design, various practices, etc. In this context, the issue of digitalizing the process of diploma design is the most relevant since explanatory notes to qualification works must be kept at the university upon graduation and go through several stages to be admitted to defense. The article presents the experience of the Zhytomyr Polytechnic State University in digitalizing the process of diploma design. The procedure of preparing and defending a qualification work with a detailed description of each step is presented.

Keywords
digitalization of higher education, diploma design, qualification work, university portal, Zhytomyr Polytechnic State University

1. Introduction

The last few years in Ukraine (pandemic, war) have contributed to the rapid digital transformation of all forms of education. Higher education is no exception. Unlike general secondary education institutions, several processes were conducted exclusively in person in higher education institutions. However, the situation in which Ukraine has found itself since February 2022 has also contributed to the development of digitalization of all processes in higher education.

For example, higher education institutions have such forms of control as course design, diploma design, various internships, etc. In this context, the digital transformation of diploma

design is the most relevant since explanatory notes to qualification works must be kept at the university upon graduation and go through several stages to be allowed to defend.

Therefore, it was decided to bring the preparation for the defense of diploma design to a new level through digital transformation in martial law.

Based on the legislation of Ukraine [1, 2], in 2022, Zhytomyr Polytechnic issued an order to experiment with the use of digital documents and electronic signatures during the diploma design and defense of qualification works in the specialty 121 "Software Engineering". By [1], an original digital document is an electronic copy of a document with mandatory details, including the author's electronic signature. The legal force of such a document cannot be denied solely because it has a digital form [1].

2. Theoretical Background

Tetiana V. Sych, Yevhen M. Khrykov, and Olga M. Ptakhina have identified trends in the development of higher education that are due to its digitalization, among which it is worth paying attention to some of them, namely educational digital technologies have great potential in assessing and accounting for educational activities; introduction of a mixed form of the educational process; practical orientation of educational systems. As a result, the authors conclude that "the modern digital transformation of education is the primary means of developing higher education and extends to all areas of activity of contemporary universities"[3].

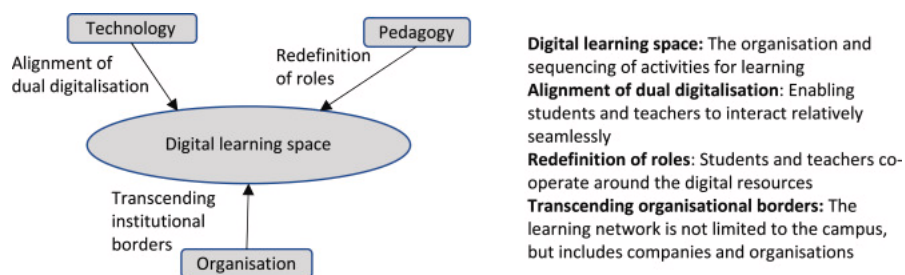The team of authors [4] presented the digital education space in the form of a diagram (figure 1).

Figure 1: Digital learning space [4].

Scientists define the digital learning space as a set of three components: technical, pedagogical, and organizational. The authors describe the technical component as combining digital education and digital subjects. They see the pedagogical element for the redefinition of roles between participants in the educational process in the digital learning space. The researchers see the organizational component in the interaction of institutions with the broader society through the digital learning space [4].

Another team of authors considers the feasibility of using Google's digital tools to organize the educational process in crisis social situations (the authors distinguish between the pre-COVID, COVID-19, and military periods of higher education in Ukraine). The researchers argue that distance learning contributes to the safety of the subjects of the educational process.

After all, distance learning provides "fast communication, operational planning, re-planning, documentation, storage, and ensures student access to learning materials, diversification of ways to achieve results" [5].

In [6], the authors define the areas of influence (professional, environmental, functional) of the virtual environment on the university and propose their methodology for assessing the level of digitalization of higher education institutions. To determine the level of university digitalization, researchers suggest three groups of indicators: digitalization of the educational process, digital literacy of students, and digital literacy of teachers [6].

In [7], the possibilities of using various digital educational tools and digital learning platforms in the educational process are considered. The author also cites several problems that may arise in the process of such implementation [7].

Various scholars have also conducted studies of distance learning [8] and the possibility of using multiple types of digital educational resources about the educational process as part of the digital transformation of the educational process [9], didactic aspects of the digitalization of university education [10, 11], and the global digitalization of the academic and scientific space [12].

However, research shows that the issue of digitalization of the process of admission to the defense of theses has not yet been studied.

3. Results

As part of the digital transformation of all educational processes at Zhytomyr Polytechnic State University, an information system was developed to include a module responsible for the diploma design process, from accepting papers for the defense to the actual reason.

The digitalization of the diploma design process makes it possible to significantly increase the efficiency of the process of writing a qualification work, switch to electronic documents and eliminate the need to use paper copies of documents, speed up communication between all participants in this process, prevent potential corruption, and organize the practical work of the examination committee during defenses. The most important advantage provided by the proposed approach and the developed software product is to offer a real possibility of remote protection of qualification works in conditions when the higher education student, supervisor, reviewer, chairman, and members of the examination committee are in different places and communicate using Internet communication and have the opportunity to familiarize themselves and work with documents (qualification work, review, feedback, certificate of verification of employment for borrowing, etc. All papers are signed with electronic signatures and uploaded to the information system "Zhytomyr Polytechnic Portal" (from now on – IS). This allows for organizing an electronic repository of qualification works and related documents.

By digitalization of the diploma design process, we mean the complete transition of all stages of diploma design from paper to digital, including submission of the work in digital format, digital signature, review by the supervisor and return for revision, digital signature of the supervisor, generation of supervisor's feedback and external reviews with digital signatures, etc.

The whole process of writing and defending qualification papers is divided into eight steps

(figure 2). However, they are preceded by a preparatory stage where the secretary of the examination board enters information into the IS. It involves entering the composition of the examination committee (figure 3) and, for each higher education student, the topic of the qualification work, supervisor, and reviewer.
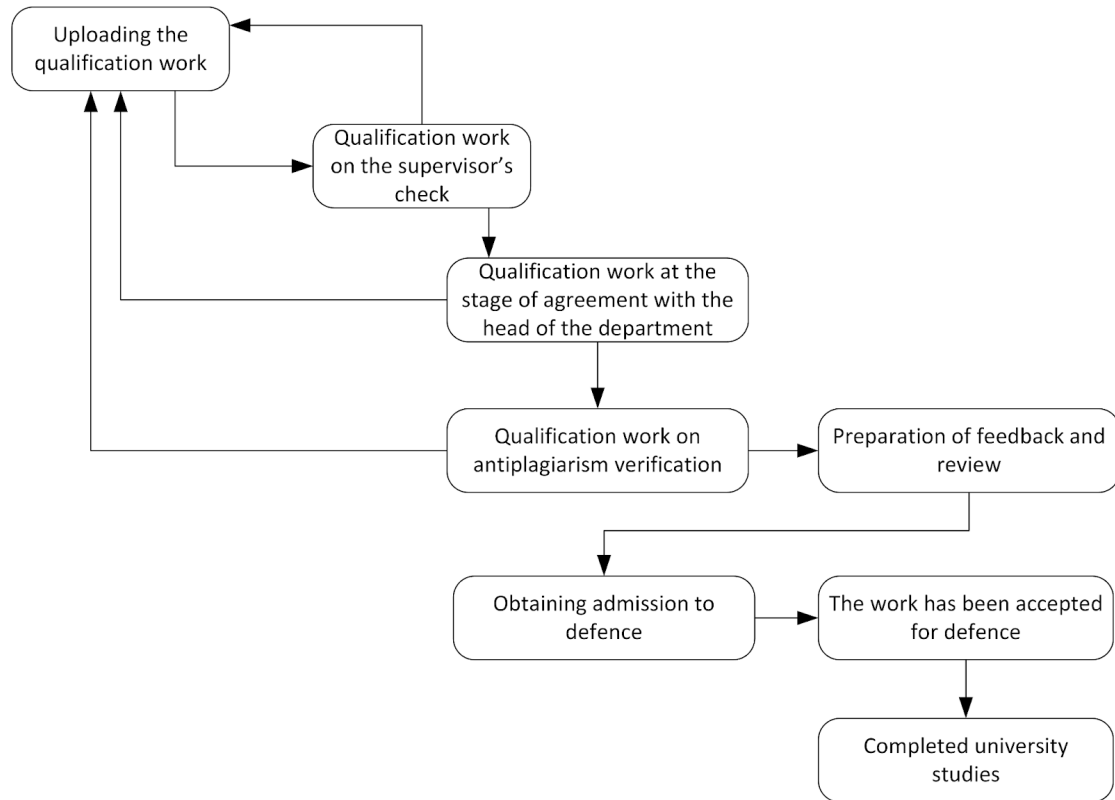

Figure 2: procedure of the preparation and defense of qualification work.

Figure 4 shows the view of the page for viewing the list of qualification works by the secretary of the examination committee. It is possible to select the specialty and educational program, educational degree, and graduation date of higher education applicants.

After the secretary of the examination board adds the initial information (figure ??), the relevant higher education student, supervisor, consultant, and reviewer members of the examination board have access to the Qualification Papers module. There are eight stages for each paper:

- Uploading a qualification paper
- Qualification paper for supervisor's review
- Qualification work for approval by the head of the department
- Qualification work for checking for borrowing
- Preparing a review and review of the work
- Obtaining admission to the defense

Figure 3: Formation of the composition of the examination committee.

Figure 4: Viewing the list of jobs by the secretary.

- The work is admitted to the defense
- Completed training

At each stage, the following roles of the subjects of the educational process are envisaged:

- Higher education applicant – uploads the qualification work, can withdraw it for revision, can view all documents that will be attached at each stage;

- Supervisor/consultant – reviews the qualification work, has the opportunity to send it back for revision, noting deficiencies, or sign the work and submit it to the next stage; prepares and signs a review of the qualification work; has the opportunity to review all documents related to the qualification work;
- Head of the department – can view the general list of higher education students and the stages of each qualification work; has access to view all qualification works and accompanying documents; for each work that is approved by the head, can put their electronic signature or send the work for revision, noting the shortcomings;
- The employee responsible for checking the work with anti-plagiarism systems – uploads the qualification work file to the specialized software used by the higher education institution to check qualification works for borrowing; generates and uploads borrowing certificates to the IS; has the opportunity to return the qualification work for revision in case of non-compliance with regulatory documents;
- Reviewer – can review qualification papers and accompanying documents and download the review file;
- Secretary of the Examination Board – has full access to view all documents for each qualification work; enters information about the supervisor, reviewer, and topics of qualification works into the IS; checks documents and admits to the defense; enters information about the date, time and place of the defense into the IS; enters information about the grade received by the applicant at the defense;
- An employee of the examination board – has the opportunity to review qualification works that are allowed for defense and all accompanying documents.

At the first stage of the process, the higher education applicant uploads the qualification work, which is signed with an electronic signature, through a personal electronic account (figure 5).

Next, the qualification work is submitted to the supervisor for consideration. At this stage, the higher education applicant is displayed an informational message about the need to wait for the decision of the work supervisor. The applicant can also withdraw the work and return to the previous stage, "Uploading qualification work".

For the work manager in the IS, the main page and the left menu display the number of tasks waiting for review and feedback. For convenience, the numbers for the supervisor in the left menu are displayed in different colors: the number of tasks pending review is in red, and the number of functions for writing a review is in orange. A list of tasks assigned to the supervisor will be displayed by clicking on the corresponding menu item. If this user has other roles, they will also see information about the number of pending tasks (figure 6).

After selecting the qualification work, you will be taken to a page that displays general information about the work and learning outcomes of the higher education applicant, including grades for the entire period of study and summary statistics of tests and exams. For the convenience of viewing the qualification work and, at further stages, the accompanying documents, it is possible to view each document directly in the browser and the ability to download the copy by clicking on the appropriate button (figure 7).

At the bottom of the window, a panel is displayed that allows you to notify the higher education student and record the decision made by the supervisor of the qualification work in the IS. If the work meets all the requirements, the supervisor must sign it with an electronic
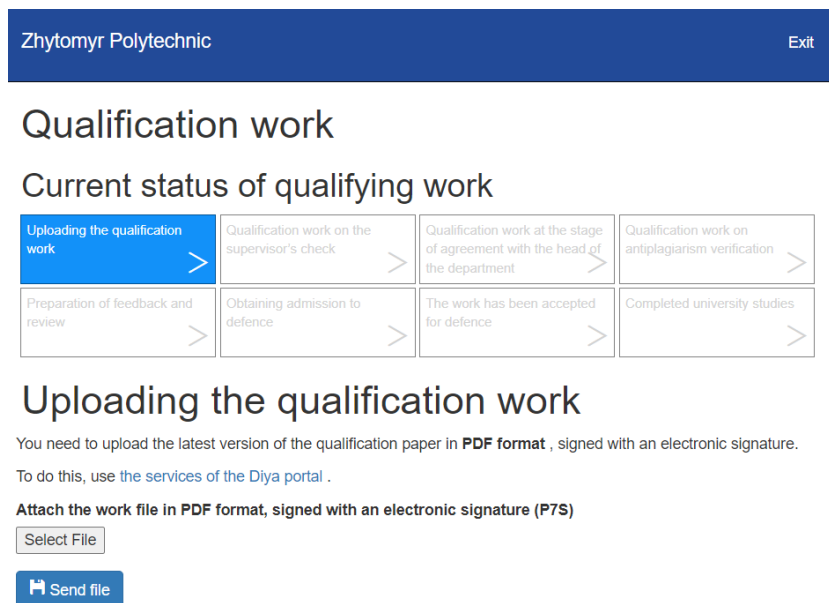
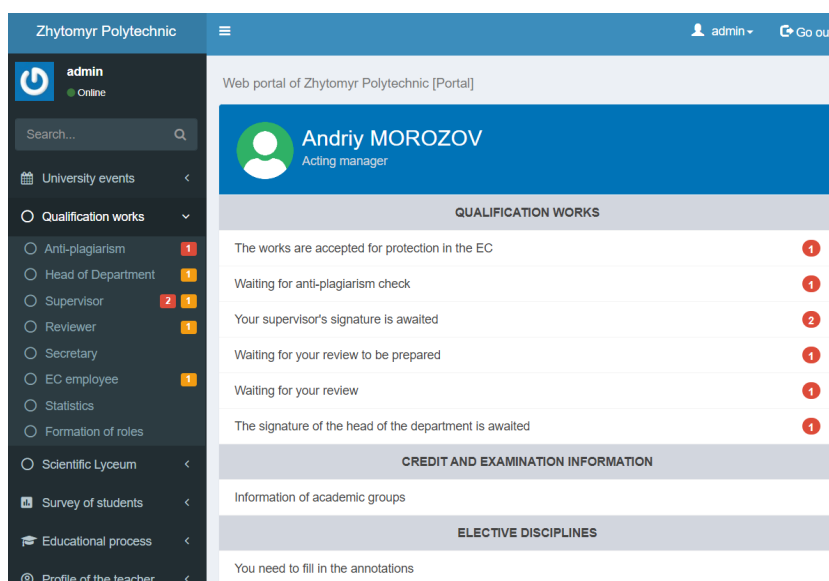**Figure 5:** Interface for uploading a qualification work by a higher education student.

Figure 6: Home page of the information system "Zhytomyr Polytechnic Portal".

signature, upload the file to the appropriate form, and click the button to transfer the work to the next stage (figure 8).

If the work contains deficiencies and needs to be revised, the supervisor must describe them appropriately and click the button to return the work to the applicant for revision (figure 9).
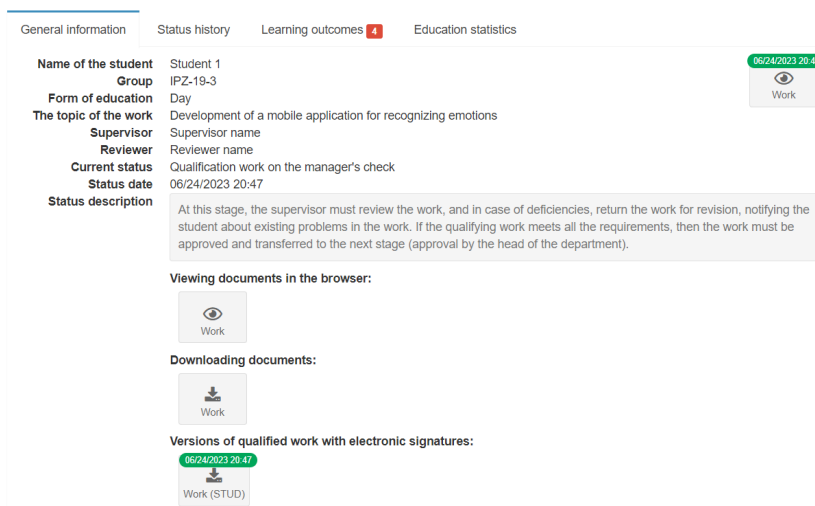
Figure 7: Viewing general information about the work by the supervisor.
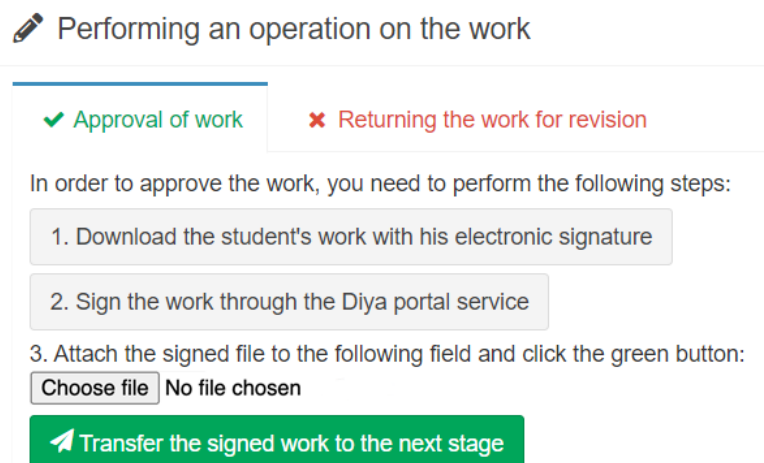

Figure 8: Interface for approval of qualification work by the supervisor.

After that, the applicant will see a notification in the electronic cabinet and will be able to download a new version of the qualification work.

If the supervisor approves the work, it is transferred to the next stage – approval by the head of the graduating department. At this stage, the head of the department has two options. The first option is to approve the work, sign it electronically, and submit it to the next stage. The second option is to return the result for revision to the higher education student with an indication of the shortcomings. The interface for the head of the department is implemented similarly to the interface of the head (figure 8, 9).

If the head of the department has passed the work to the next stage, the result is placed in the queue for checking for borrowings. At this stage, the responsible person uses a particular
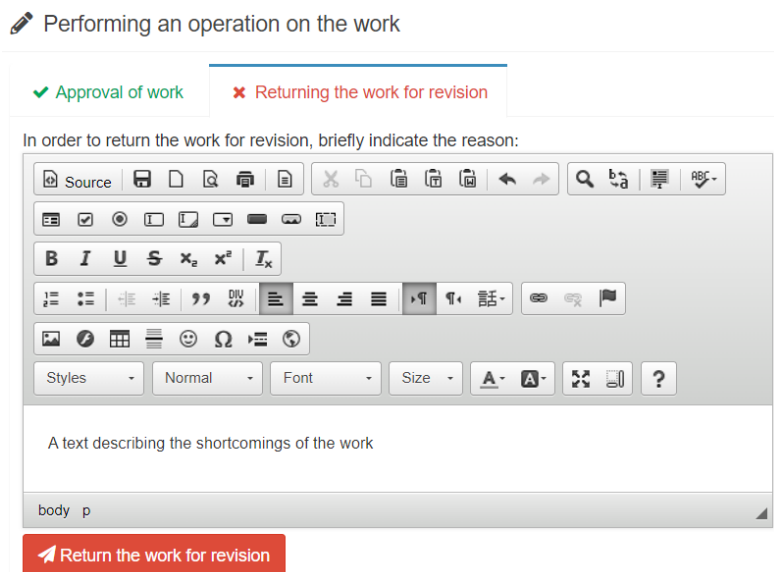
Figure 9: Interface for returning work for revision.

software product to analyze the content of the qualification work for borrowings from other sources. If borrowings are found, the amount and sources of each borrowing are determined. The information is formalized in the form of two certificates. The first certificate is generated in the software product used for the verification. The second certificate is a conclusion on the compliance of the work with the internal regulations of the higher education institution and the legislation in general. Each document is electronically signed and uploaded to the IS, which allows all participants in preparing and defending a qualification work to work with the documents as official (figure 10).
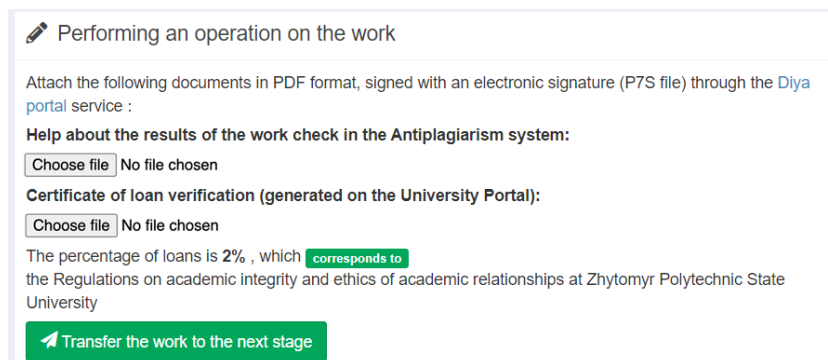

Figure 10: Interface for uploading documents for checking qualification work for borrowing.

Suppose the qualification work is inconsistent with the regulatory framework and legislation. In that case, the result is returned to the higher education applicant for revision and must go through all the previous stages, starting with the first. If the work is found to comply, it proceeds

to the next step – preparation of the supervisor's feedback and writing a review by the reviewer.

For the supervisor (figure 11, 12) and the reviewer, forms have been implemented that they must fill out in the IS. After filling out the forms, it is possible to generate PDF versions of the feedback and review, which must be downloaded and signed with an electronic signature and uploaded to the IS.

Figure 11: Formation of the supervisor's feedback (part 1).

Figure 12: Formation of the supervisor's feedback (part 2).

After generating and uploading the signed feedback and review to the IS, the work proceeds to the next stage – obtaining admission to the defense. At this stage, the secretary of the exami-

nation committee checks the conditions for securing access to the reason (internal regulations may set these conditions and may differ from one higher education institution to another). If the applicant cannot be admitted to the security, the reason is indicated in the appropriate field of the form (figure 13).

Figure 13: Form of admission of a higher education student to the defense.

Suppose a higher education student is admitted to the defense. In that case, the secretary must additionally fill in the fields that indicate the date and time of the reason, the link for online connection, or the place of the defense (figure 14).
.

Upon completion of the defense, the secretary of the examination committee enters the grade received by the higher education student in the appropriate field in the IS.

4. Discussion

Using the proposed IS module, during 2022-2023, 148 bachelor's degrees and 31 master's degree qualification works were defended in the specialty 121 "Software Engineering". All participants in preparing and supporting qualification works could obtain electronic signatures through Internet banking systems or the State Tax Service and use them to sign documents.

At the same time, in the process of implementing this module of the information system, some problematic issues were identified:

Figure 14: Entering information about the date, time, and place of defense.

- the need to conduct training and consultations on the use of electronic signatures for students and teaching staff;
- the difficulty of obtaining electronic signatures in Ukraine for foreign applicants;
- dependence on the Internet connection (in case of loss of connection, it is impossible to access electronic documents).

5. Conclusions

The approach to the preparation and defense of qualification papers using the advantages provided by the digitalization of this process, proposed and implemented at the Zhytomyr Polytechnic State University, was tested during 2022-2023 and showed an improvement in the quality of both qualification papers and accompanying documents. This is primarily due to a shift in the focus of higher education students and those involved in the preparation and defense of qualification papers, from producing paper copies of documents to their quality and content. In case of deficiencies, the need to reprint documents has been eliminated; it is enough to create a new version of the document and sign it with an electronic signature. The need to collect the signatures of the manager, reviewer, and head of the department in person was eliminated. This has significantly reduced the time spent preparing and signing the relevant documents. The prospects for further research include external expert evaluation of both the portal as a whole and individual modules.

References

[1] Law of Ukraine "On Electronic Documents and Electronic Documents Circulation", 2022. URL: https://zakon.rada.gov.ua/laws/show/851-15#Text.
[2] Law of Ukraine "About electronic trust services", 2023. URL: https://zakon.rada.gov.ua/laws/show/2155-19?lang=en#Text.

[3] T. Sych, Y. Khrykov, O. Ptakhina, Digital transformation as the main condition for the development of modern higher education, Educational Technology Quarterly 2021 (2021) 293–309. URL: https://acnsci.org/journal/index.php/etq/article/view/27. doi:`10.55056/etq.27`.

[4] B. Bygstad, E. Øvrelid, S. Ludvigsen, M. Dæhlen, From dual digitalization to digital learning space: Exploring the digital transformation of higher education, Computers & Education 182 (2022) 104463. URL: https://www.sciencedirect.com/science/article/pii/S0360131522000343. doi:`10.1016/j.compedu.2022.104463`.

[5] T. Vdovychyn, U. Kohut, O. Sikora, Google digital tools for organization of the pedagogical university's educational process in crisis situations, Information Technologies and Learning Tools 92 (2022) 75–98. URL: https://journal.iitta.gov.ua/index.php/itlt/article/view/5093. doi:`10.33407/itlt.v92i6.5093`.

[6] M. N. Belousova, V. A. Belousov, L. V. Narkevich, Digital Transformation of the Educational Process in University in the Context of Globalization", bookTitle=, ????

[7] Ciarko, Marta, Paluch-Dybek, Agnieszka, The importance of digitalization in the education process, E3S Web Conf. 307 (2021) 06002. doi:`10.1051/e3sconf/202130706002`.

[8] T. A. Vakaliuk, O. M. Spirin, N. M. Lobanchykova, L. A. Martseva, I. V. Novitska, V. V. Kontsedailo, Features of distance learning of cloud technologies for the organization educational process in quarantine, Journal of Physics: Conference Series 1840 (2021) 012051. doi:`10.1088/1742-6596/1840/1/012051`.

[9] T. A. Vakaliuk, O. V. Chyzhmotria, O. H. Chyzhmotria, S. O. Didkivska, V. V. Kontsedailo, The use of massive open online courses in teaching the fundamentals of programming to software engineers, Educational Technology Quarterly 2023 (2023) 106–120. URL: https://acnsci.org/journal/index.php/etq/article/view/37. doi:`10.55056/etq.37`.

[10] M. A. Abysova, M. H. Kravchuk, O. M. Hurniak, Digitalization in university education: didactic aspects, Information Technologies and Learning Tools 93 (2023) 68–79. URL: https://journal.iitta.gov.ua/index.php/itlt/article/view/5097. doi:`10.33407/itlt.v93i1.5097`.

[11] O. V. Talaver, T. A. Vakaliuk, Reliable distributed systems: review of modern approaches, Journal of Edge Computing 2 (2023) 84–101. URL: https://acnsci.org/journal/index.php/jec/article/view/586. doi:`10.55056/jec.586`.

[12] V. Lugovyi, I. Reheilo, N. Bazeliuk, O. Bazeliuk, Global digitisation of the education and research area and challenges in modernising the scientific periodicals of naes of Ukraine, Information Technologies and Learning Tools 73 (2019) 264–283. URL: https://journal.iitta.gov.ua/index.php/itlt/article/view/3366. doi:`10.33407/itlt.v73i5.3366`.