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THE IMPACT OF DEVOPS METHODOLOGIES ON THE DEVELOPMENT OF IT STUDENTS' DIGITAL COMPETENCIES

Abstract. This article investigates how the integration of information and communication technologies (ICT), with a focus on DevOps methodologies, can transform the educational process within higher education institutions to better prepare students for working in modern IT teams. The study aims to quantify and qualitatively evaluate the effect of DevOps tools such as GitHub, GitLab, Docker, Kubernetes, Jenkins and AWS/Google Cloud/Azure cloud services on developing key professional competencies such as teamwork, critical thinking and digital literacy.

As part of the experimental approach, two groups of 30 students each took a course incorporating DevOps practices or traditional teaching without a DevOps component. A mixed methodology was employed, comprising a Likert questionnaire ($\alpha = 0.82$) to evaluate satisfaction with the learning process, digital literacy and self-evaluation of team skills, as well as an analysis of CI/CD technical metrics (build time and percentage of successful launches) and repository activity.

The results show that implementing the DevOps approach increased the average satisfaction score from 3.2 ± 0.7 to 4.1 ± 0.6 ($p < 0.01$) and improved digital literacy (from 2.8 ± 0.8 to 4.0 ± 0.5) and teamwork self-assessment (from 3.0 ± 0.6 to 4.2 ± 0.4, $p < 0.05$). Technical build time was reduced by 35%, while the success rate of CI/CD pipelines increased from 78% to 92%. Concurrently, the number of repositories doubled, indicating increased student engagement.

The most significant challenges were the lack of digital literacy among teachers and the complexity of setting up the CI/CD infrastructure initially (cited by 20%-15% of respondents). Based on the obtained data, the following recommendations for optimising educational programmes were developed: introducing teacher training courses; creating template laboratory stands with pre-configured DevOps tools; and implementing practical tasks in phases with the support of mentors.

These findings confirm that systematically applying ICT and DevOps methodologies in higher education contributes to producing competitive specialists who can work effectively in the context of digital transformation and the globalisation of the IT market.

Keywords: information and communication technologies; DevOps; digital education; cloud services; digital literacy.

1. INTRODUCTION

The problem statement. Information and communication technologies are fundamentally changing the way we teach, making it more flexible, accessible and interactive. The use of cloud services, collaboration platforms, automated assessment systems and DevOps simulators allows students to gain real-time knowledge and practice in a controlled environment.

An important aspect is to analyse how ICTs affect the learning process, what benefits and challenges they create, and what methods allow for their most effective use. The introduction of DevOps approaches into the education system is particularly relevant, as this approach facilitates the integration of automation, continuous learning and the rapid introduction of new technologies into curricula.

Modern education must meet the requirements of digital transformation, providing students with not only theoretical knowledge but also practical experience with real-world

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technologies. In the context of globalisation and the development of technology, distance learning is becoming an integral part of the educational process, requiring the use of effective ICT tools to organise the learning environment, conduct laboratory work and control knowledge.

Despite the numerous benefits of using information and communication technologies in education, their implementation is accompanied by certain challenges. In particular, one of the key tasks is to adapt teachers to new digital platforms and teaching methods, which requires additional training and resources. There is also a risk of a digital divide, when students with limited access to modern technologies find themselves in unequal conditions compared to those with greater opportunities to use ICT.

Cybersecurity issues pose a separate challenge, as the use of open online platforms increases the risk of confidential information leakage and unauthorised access to learning materials. In addition, over-reliance on digital technologies can negatively affect the development of students' critical thinking, as simplified access to information often reduces the motivation to analyse and study material in depth.

In view of this, it is necessary to consider ways to optimally use ICT and DevOps methodologies in the educational process, which will help improve the quality of education and train competitive specialists.

Analysis of recent studies and publications. Analysis of modern research shows a significant impact of information and communication technologies on the educational process [1, 2]. The use of ICT helps to increase student engagement, develop their independence, critical thinking and teamwork skills [3]. Researchers pay special attention to the effectiveness of digital platforms in education [4], which allow not only to automate the processes of assessment and control of knowledge, but also to create flexible adaptive learning systems.

A study [5] shows that the integration of cloud technologies significantly reduces the cost of educational infrastructure, while improving students' access to learning materials at any time and from any location. The use of cloud-based platforms for distance learning is especially relevant, as it has proven to be effective during the COVID-19 pandemic [6].

Study [7] emphasises the role of DevOps approaches in creating adaptive learning environments. The use of DevOps in educational courses allows students to work with real-world tools for software development, testing, and deployment [8]. The use of CI/CD processes, containerisation (Docker, Kubernetes) and cloud services facilitates the modelling of real-life work scenarios, which improves the quality of practical training of future professionals.

Study [9] draws attention to the impact of ICT on student motivation. It has been found that interactive platforms (Moodle, Google Classroom, Microsoft Teams) and game-based teaching methods increase students' interest in the learning process, increase their activity level and contribute to better learning [10].

The issue of cybersecurity is also extremely relevant, as learning platforms contain personal data of students and teachers, and the risks of hacking and information leakage are increasing with the growing use of cloud services [11, 12]. Much attention is also paid to the digital literacy of teachers [13], as the successful implementation of ICT and DevOps approaches is possible only if all participants in the educational process are properly trained [14].

A separate area of research is related to the impact of ICT on students' cognitive abilities [15]. Some scholars [16] note that excessive automation and the use of artificial intelligence can lead to a decrease in students' critical thinking and analytical skills, which requires additional mechanisms to balance traditional and digital teaching methods.

Thus, the analysis of recent studies demonstrates the significant benefits of using information and communication technologies in the educational process, but requires further

research on their long-term impact, as well as the development of mechanisms to address possible risks and challenges.

The research goal. The aim of the study is to analyse the impact of ICT, in particular the DevOps methodology, on the educational process, identify their advantages and challenges, and develop recommendations for the effective use of digital technologies in higher education.

2. RESEARCH METHODS

Several complementary research methods were used to provide a comprehensive analysis of the impact of information and communication technologies on the educational process. This approach allows to obtain an objective picture of the changes taking place in education under the influence of digital technologies, as well as to evaluate the effectiveness of integrating DevOps approaches into academic disciplines.

An experimental approach was used to test DevOps methods in academic disciplines, including the integration of practical classes using GitHub, GitLab, Jenkins, Docker, Kubernetes, and cloud services (AWS, Google Cloud, Azure). As part of the experiment, students were asked to complete a number of tasks related to software deployment automation, code version management, setting up CI/CD processes, and monitoring system performance.

In order to study the impact of information and communication technologies on the educational process comprehensively, a mixed methodological approach was chosen that integrates quantitative and qualitative methods. The participants were 60 IT students, aged 3–4 years, who were majoring in Information Systems and Technology at Lviv Polytechnic National University. They were selected by a stratified random sample and divided into two equal-sized groups: an experimental group of 30 people who worked with DevOps tools, and a control group of 30 people who used a traditional teaching model without a DevOps component.

For the quantitative stage of the study, a five-point Likert scale questionnaire was used to assess satisfaction with the learning process, digital literacy levels, and self-assessment of teamwork. The questionnaire's reliability was confirmed by Cronbach's coefficient $\alpha = 0.82$, indicating high internal consistency.

The results of the experiment allow us to evaluate the effectiveness of DevOps in the educational process, determine the benefits of this approach, and identify potential difficulties faced by students and teachers when working with new technologies. The analysis of the data obtained will help to develop recommendations for optimising educational programmes to meet the requirements of the modern digital environment.

3. THE RESULTS AND DISCUSSION

3.1. Impact of ICT on the learning process

The analysis of the data obtained confirmed that the introduction of information and communication technologies in the educational process significantly improves its effectiveness, making education more interactive, adaptive and practice-oriented. The use of digital technologies helps to increase the level of student engagement, improve access to learning resources and expand opportunities for gaining practical experience.

One of the key areas of ICT impact is the integration of cloud technologies such as AWS, Google Cloud and Microsoft Azure. The use of cloud services allows students to work with real infrastructures, test software deployments, automate processes and perform tasks related to DevOps approaches. This makes it possible to simulate real-life work scenarios, which significantly improves the level of training of future IT professionals. For example, students

can create virtual servers, set up CI/CD processes, and analyse the operation of applications in the cloud environment.

Learning management systems (LMS), such as Moodle, Canvas, Google Classroom, and Blackboard, play an important role in the digital transformation of education. These platforms allow automating the learning process, delivering distance learning, integrating various learning resources, and assessing students' knowledge in real time. LMSs also facilitate the personalisation of the learning process by enabling curricula to be tailored to meet the individual needs of each student.

Another important aspect is the use of collaboration platforms such as GitHub, GitLab, Jira, Trello, and Confluence. They help students develop teamwork, project management, and Agile methodologies. Working in such environments helps students understand the principles of DevOps, DevSecOps, and CI/CD, which is critical for training IT professionals. For example, as part of the courses, students can create collaborative projects, manage code versions, distribute tasks using the Scrum methodology, and conduct code reviews, which brings their experience closer to the real working conditions in IT companies.

In addition, interactive and game-based teaching methods, including the use of virtual reality (VR) and augmented reality (AR), have a significant impact on the learning process. These technologies allow students to interact with learning material in new formats, which is particularly effective for engineering and technical disciplines. For example, in medical and aviation disciplines, VR simulations help students perform virtual surgeries or operate flight simulators, gaining practical experience without risk to life and health.

It is also important to introduce artificial intelligence (AI) and machine learning into the educational process. Adaptive learning systems based on AI can analyse students' knowledge levels and offer them individual learning paths. For example, AI-powered platforms can automatically select learning materials, test tasks, and interactive exercises according to student progress, which contributes to more efficient knowledge acquisition.

Despite all the benefits, the active introduction of ICT in the educational process is accompanied by a number of challenges. In particular, the insufficient level of digital literacy among teachers can make it difficult to use modern technologies in teaching. There is also the issue of cybersecurity, as there is a growing risk of confidential information leakage, unauthorised access to educational materials, and attacks on educational platforms.

Thus, the use of ICT in the educational process significantly expands opportunities for students and teachers, promotes more effective learning, develops practical skills and provides a deeper immersion in professional activities. At the same time, it is necessary to develop strategies to overcome the challenges associated with the digital transformation of education in order to make the most of the potential of modern technologies.

Traditional teaching approaches and DevOps-oriented learning have significant differences that affect the effectiveness of learning and the preparation of students for work in the IT industry. The DevOps methodology focuses on the practical application of technology, integration of modern tools, and process automation. Table 1 shows a comparison between the traditional and DevOps-oriented approach to education.

Table 1

Comparison of the traditional and DevOps-oriented approach to learning

Criterion	Traditional approach	DevOps-oriented approach
Teaching methodology	Lecture and seminar system	Practice-oriented training with the use of DevOps tools
Access to resources	Standard teaching materials	Cloud technologies, interactive platforms, simulators
Practical training	Laboratory work with a limited environment	Working with real DevOps tools (CI/CD, Docker, Kubernetes)

Collaborative work	Individual tasks	Using GitHub, GitLab, Jira for team development
Assessment	Standard tests and exams	Automated testing, DevOps metrics, project portfolio
Work readiness	Theoretical training	Practical skills for the real IT industry

3.2. The role of ICT in DevOps training

Modern information and communication technologies are the basis for the implementation of effective DevOps training, as they provide flexibility, accessibility and practical orientation of the educational process. Thanks to ICT, students get the opportunity to work with real DevOps tools, which allows them to develop digital competencies and be ready to work in IT companies.

Figure 1 illustrates the main areas of use of information and communication technologies in the DevOps educational process. It demonstrates key aspects such as the use of version control platforms, automation of development processes, containerisation, use of cloud technologies, monitoring, configuration management, and simulation training. These areas ensure effective training of future DevOps professionals, allowing them to gain practical skills in working with modern tools and techniques.

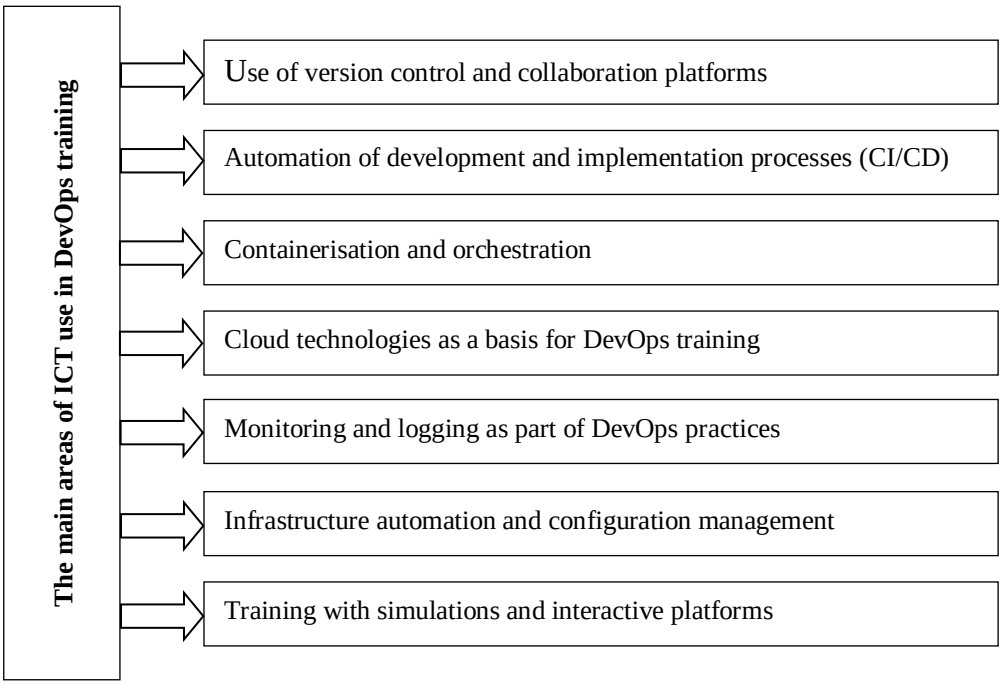

Figure 1. Main areas of ICT use in DevOps training

Using version control and collaboration platforms is an important element of DevOps training. Tools such as GitHub, GitLab, and Bitbucket provide a way to collaboratively develop and control software code. Integration of the GitOps approach allows students to work in a team, similar to real IT projects. In addition, the use of GitHub Classroom helps to automate task checking and implement CI/CD processes in the educational process.

Automation of development and deployment processes is another key aspect of DevOps training. Using tools such as Jenkins, GitLab CI/CD, GitHub Actions, CircleCI, and TravisCI helps students learn how to set up automated pipelines for building, testing, and deploying software. Applying the Infrastructure as Code (IaC) approach using Terraform and Ansible

allows you to better understand the principles of infrastructure management automation, which is an integral part of modern DevOps processes.

Containerisation and orchestration play an important role in DevOps training, allowing students to model microservice architecture, create replicable environments, and deploy applications in cloud infrastructures. The use of Docker, Kubernetes, Podman, and OpenShift helps students learn the principles of load balancing, automatic scaling, and efficient resource management. Kubernetes, in particular, provides an opportunity to understand the mechanisms of coordination of containerised applications in large distributed systems.

Cloud technologies are the basis of modern DevOps training, as they allow students to work with tools that are widely used in the IT industry. The AWS, Microsoft Azure, Google Cloud Platform (GCP), and DigitalOcean platforms provide access to cloud computing, data storage, and distributed services. Training programmes such as AWS Educate, Google Cloud Skills Boost and Microsoft Learn provide students with free credits for hands-on experimentation without significant financial outlay. The use of serverless computing, including AWS Lambda and Google Cloud Functions, allows you to learn the latest approaches to optimising infrastructure and deploying applications.

Monitoring and logging are important components of DevOps practices, as they provide control over the performance and stability of software systems. Tools such as Prometheus, Grafana, ELK Stack (Elasticsearch, Logstash, Kibana), Splunk, and Datadog allow you to collect, analyse, and visualise system metrics. Grafana is used to create interactive dashboards that help students learn real-time application analysis and make informed decisions about optimising their applications.

Infrastructure automation and configuration management are an integral part of modern DevOps approaches. The use of Infrastructure as Code (IaC) technology allows students to learn how to create, configure, and manage infrastructure using code. Terraform, Ansible, Puppet, and Chef tools provide the ability to automate server management processes, reducing the risk of human error and increasing the efficiency of administration. Ansible, in particular, is widely used to automate server configurations and orchestrate complex IT environments, which is important for developing students' practical skills.

Learning through simulations and interactive platforms greatly simplifies the process of mastering DevOps tools, allowing students to gain hands-on experience in a secure environment without the need to install additional software. Platforms such as Katacoda, KodeKloud, Linux Academy, Udemy, and Coursera offer interactive scenarios that simulate real-world tasks faced by DevOps engineers. The use of virtual labs allows you to study at a convenient time and from any location, making DevOps education more accessible and effective.

The introduction of information and communication technologies in DevOps education contributes to a significant increase in the level of practical training of students, giving them the opportunity to work with real DevOps tools and gain valuable experience while studying. As a result, graduates of educational programmes will be better prepared to work in DevOps teams and will be able to immediately apply the knowledge gained in real projects.

Adapting the educational process to the needs of the IT industry allows us to create study programmes that meet the current requirements of the labour market. Involving students in working with cloud platforms, CI/CD pipelines, infrastructure automation systems, and monitoring tools allows them to acquire skills that are highly valuable to employers.

The use of free and open-source technologies helps to reduce barriers to the implementation of DevOps methodologies in the educational process, providing access to innovative solutions without significant financial costs. This helps to expand learning opportunities and create equal conditions for students regardless of their resources.

Digital competences are developed through the integration of modern platforms and methodologies into courses. Students develop skills in teamwork, process automation,

monitoring and infrastructure management, which allows them to work effectively in a dynamic DevOps environment.

Thus, information and communication technologies are a key element of effective DevOps training, creating an interactive, practice-oriented environment that fully meets the requirements of the modern IT market.

3.3. Examples of successful ICT implementation

Successful integration of information and communication technologies into DevOps training provides students with access to practical experience and modeling of real work processes. Let's look at a few cases that demonstrate the effectiveness of such approaches.

3.3.1 Using Docker and Kubernetes in the educational process.

A course on containerization and application orchestration was developed. Students learned how to create and manage containerized services using Docker to deploy applications and Kubernetes to manage their infrastructure. This allowed not only to improve technical skills but also to prepare students for the real working conditions in DevOps teams. As a result, the graduates were able to successfully pass interviews and quickly adapt to the requirements of the labor market.

3.3.2. Automation of code testing using CI/CD (Jenkins, GitHub Actions).

A project-based approach was introduced, in which students developed their own software solutions with the mandatory integration of CI/CD processes. Using Jenkins, GitHub Actions, and GitLab CI/CD, they set up automatic code testing, static security analysis, and automated application deployment in test environments. This allowed the students to gain hands-on experience with continuous integration and deployment, which is an important component of modern DevOps.

3.3.3 Use of virtual laboratories (Microsoft Learn, AWS Educate, Google Cloud Skills Boost).

To expand access to real DevOps tools and environments, virtual laboratories based on Microsoft Learn, AWS Educate, and Google Cloud Skills Boost were implemented. Thanks to these platforms, students were able to perform practical tasks on cloud infrastructure, configuration management, and infrastructure automation without the need to install additional software. This made learning more accessible and flexible, allowing students to work with technologies used in leading IT companies.

3.3.4. Deployment and monitoring in cloud environments (Prometheus, Grafana, AWS CloudWatch).

A course was developed to teach students how to collect, analyze, and visualize application performance metrics. They used Prometheus to collect server performance data, Grafana to build interactive dashboards, and AWS CloudWatch to monitor cloud services. This approach allowed students not only to master monitoring technologies but also to better understand the principles of observability in DevOps processes.

3.3.5. Application of Agile and DevOps methodologies in educational projects (Jira, Confluence, GitHub Projects).

In addition to technical skills, students were taught to work according to Agile methodologies and apply DevOps approaches in organizing teamwork. For this purpose, Jira and Confluence were used for task management, GitHub Projects for code collaboration, and CI/CD pipelines for automating development processes. This allowed students to gain real-

world experience in project work, which significantly increased their competitiveness in the labor market.

Thus, successful examples of the introduction of information and communication technologies in DevOps education demonstrate the high efficiency of the practice-oriented approach. They not only improve the assimilation of theoretical knowledge, but also contribute to the acquisition of real skills that meet the needs of the modern IT market.

For the effective implementation of DevOps methodologies in the educational process, it is necessary to use modern technologies that allow students to gain practical experience in a real IT environment. Tools for version control, CI/CD automation, containerization, monitoring, and infrastructure management form the basis of digital education in DevOps. Table 2 shows the main DevOps technologies that are actively used in the educational process.

Table 2

Main DevOps technologies used in education

Category	Technology	Description
Version control	Git, GitHub, GitLab, Bitbucket	Collaborative code development, version control
CI/CD automation	Jenkins, GitHub Actions, GitLab CI/CD, CircleCI	Setting up continuous integration and code delivery
Containerization and orchestration	Docker, Kubernetes, OpenShift, Podman	Modeling of cloud environments and scaling
Cloud platforms	AWS, Azure, Google Cloud	Access to real DevOps infrastructures
Monitoring and logging	Prometheus, Grafana, ELK Stack	Tracking system performance and analyzing logs
Infrastructure automation	Terraform, Ansible, Puppet, Chef	Infrastructure as a Code management
Learning management systems	Moodle, Google Classroom, Canvas	Organization of the learning process and integration of DevOps methodologies

3.4 Analysis of the experimental results: quantitative and qualitative indicators

The quantitative analysis shows that applying DevOps practices to the educational process increased the average satisfaction score from 3.2 ± 0.7 to 4.1 ± 0.6 on a five-point Likert scale ($p < 0.01$). The digital literacy score in the experimental group increased from 2.8 ± 0.8 to 4.0 ± 0.5 and self-assessment of teamwork skills increased from 3.0 ± 0.6 to 4.2 ± 0.4 (all changes statistically significant, $p < 0.05$). Among the technical CI/CD metrics, build time was reduced by an average of 35%, and the percentage of successful launches increased from 78% to 92%.

Key analysis confirmed that implementing DevOps tools improves technical performance and stimulates student engagement: commits to the repository per student doubled and documentation updates tripled. Additionally, correlation analysis revealed a strong relationship between the number of practical tasks in the pipeline and the level of satisfaction with the learning process ($r = 0.68$, $p < 0.01$).

At the same time, 20 per cent of respondents reported difficulties with installing and configuring local CI/CD agents, while 15 per cent noted the excessive complexity of the initial configuration files. These results suggest the need for additional support during the initial implementation stage.

The preliminary results of the experiment demonstrate significant improvements in several key areas: satisfaction with the learning process, digital literacy and teamwork increased by 20-40%, average build time decreased by almost a third, and the success rate of pipelines surpassed 90%. Student activity in the repository doubled, indicating increased engagement in

the process. Technical difficulties in setting up the CI/CD infrastructure were the most frequent obstacle, indicating the need for additional support during the initial implementation stage.

This combination of quantitative and qualitative results demonstrates the effectiveness of the DevOps approach in the educational process and identifies areas for improvement.

4. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

The integration of information and communication technologies into the DevOps learning process significantly improves the quality of education, making it more practice-oriented, adaptive, and flexible. Thanks to the use of cloud platforms, containerization, CI/CD automation, monitoring and configuration management, students gain invaluable experience with modern technologies used in real IT teams.

Despite the significant advantages of introducing information and communication technologies into the DevOps educational process, there are still a number of challenges that require further research and improvement.

One of the key aspects is digital security, as the use of open online resources and cloud platforms requires increased attention to the protection of personal data, cyber threats, and software security.

An equally important task is to adapt curricula to the rapid changes in DevOps, which requires regular updating of courses and implementation of current practices that meet the modern requirements of the labor market.

The introduction of digital technologies also requires training of teachers, as their digital literacy and ability to effectively use DevOps tools are important factors in the successful educational process. This necessitates the development of guidelines and specialized training programs.

One of the most promising areas is the individualization of educational routes, which involves the use of adaptive educational systems and artificial intelligence to create personalized approaches to learning. This will allow students to acquire knowledge at their own pace and in accordance with their needs and level of training.

The combination of traditional and digital approaches in the form of hybrid learning models has significant potential. The use of classroom classes in combination with online courses, interactive platforms, and virtual laboratories will contribute to more effective learning and the formation of professional competencies of a DevOps engineer.

Prospects for further research may include the development of methods for assessing the effectiveness of digital learning, the introduction of innovative pedagogical technologies, and the study of the impact of ICT on the level of knowledge and practical skills of students. This will contribute to the creation of a dynamic educational ecosystem that meets the challenges of the modern IT market and provides graduates with competitive advantages in their professional activities.

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ВПЛИВ DEVOPS-МЕТОДОЛОГІЙ НА ФОРМУВАННЯ ЦИФРОВИХ КОМПЕТЕНТНОСТЕЙ СТУДЕНТІВ ІТ-СПЕЦІАЛЬНОСТЕЙ

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Анотація. У статті досліджується, як інтеграція інформаційно-комунікативних технологій (ІКТ), із фокусом на DevOps-методологіях, трансформує навчальний процес у закладах вищої освіти з метою підвищення практичної готовності студентів до роботи в сучасних ІТ-командах. Метою дослідження є кількісна та якісна оцінка впливу DevOps-інструментів (GitHub, GitLab, Docker, Kubernetes, Jenkins, хмарні сервіси AWS/Google Cloud/Azure) на

формування ключових професійних компетенцій: командної роботи, критичного мислення та цифрової грамотності.

У межах експериментального підходу дві групи студентів (30 осіб у кожній) проходили курс із інтеграцією DevOps-практик або традиційне викладання без DevOps-складової. Застосовано змішану методологію: анкетування (Likert, $\alpha = 0,82$) для оцінки задоволеності навчальним процесом, цифрової грамотності й самооцінки командних навичок; аналіз технічних метрик CI/CD (час збірки, відсоток успішних запусків) та активності в репозиторіях.

Результати свідчать, що впровадження DevOps-підходу збільшило середній бал задоволеності з $3,2 \pm 0,7$ до $4,1 \pm 0,6$ ($p < 0,01$), підвищило цифрову грамотність із $2,8 \pm 0,8$ до $4,0 \pm 0,5$ і самооцінку командної роботи з $3,0 \pm 0,6$ до $4,2 \pm 0,4$ ($p < 0,05$). Технічний час збірки скоротився на 35 %, а успішність CI/CD-конвеєрів виросла з 78 % до 92 %. Водночас кількість комітів у репозиторії зросла вдвічі, що вказує на підвищену залученість студентів.

Найсуттєвішими викликами виявились недостатня цифрова грамотність викладачів та складність початкових налаштувань CI/CD-інфраструктури (20 %–15 % респондентів). На основі отриманих даних розроблено рекомендації щодо оптимізації освітніх програм: запровадження курсів підвищення кваліфікації викладачів, створення шаблонних лабораторних стендів із попередньо налаштованими DevOps-інструментами та поетапне впровадження практичних завдань із підтримкою менторів.

Отримані висновки підтверджують, що системне застосування ІКТ і DevOps-методологій у вищій освіті сприяє формуванню конкурентоздатних фахівців, здатних ефективно працювати в умовах цифрової трансформації та глобалізації ІТ-ринку.

Ключові слова: інформаційно-комунікативні технології; DevOps; цифрова освіта; хмарні сервіси; цифрова грамотність.

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