Інформаційні програми та комп'ютерно-інтегровані технології

UNIVERSITY VIRTUAL EDUCATIONAL ENVIRONMENT INTEGRATION WITH THE ZOOM SERVICE

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Abstract. This study examines the most commonly used online meeting systems, analyzing their advantages and disadvantages, and justifies the choice of Zoom as a primary platform for organizing the educational process under conditions of digital transformation. Particular attention is given to the flexibility, scalability, and accessibility of Zoom, which make it suitable for a wide range of educational scenarios—from traditional lectures to interactive seminars and group projects. The paper explores Zoom's integration with popular learning management systems (LMS), including Moodle, Google Classroom, Microsoft Teams, and others, as well as the development of independent adapter services for linking university educational software with video conferencing platforms. The study refines the structure of an extended information system for a higher education institution, including its interaction with Zoom servers and clients, and with internal IT services. The advantages of adapting Zoom to meet the specific needs of universities are analyzed, particularly the development of custom integrations for connecting internal learning management systems, electronic gradebooks, assessment modules, timetables, and other services used in the educational environment. Such integration supports the optimization of administrative processes, facilitates instructors' work, automates routine tasks, and ensures convenient student access to learning materials in both synchronous and asynchronous modes. Special attention is also given to data protection and security issues related to the use of Zoom in educational settings. Mechanisms ensuring confidentiality and system reliability are examined in detail, including user authentication, multi-level data encryption, secure communication channels, and controlled access to learning sessions. The study concludes that integrating Zoom significantly enhances the quality,

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flexibility, and accessibility of education in the context of globalization, digitalization, and crisis-related challenges in the education sector.

Key words: video conferencing; Zoom; distance learning; Moodle; digital university environment.

Introduction

Considering the events that have taken place in the world in recent years, namely the COVID-19 pandemic and the full-scale military actions in Ukraine, educational institutions have had to adapt to these extremely challenging conditions**.** The crucial task was to maintain the stability of educational processes so that all participants — higher education students, teachers, and other employees — could communicate at any time, from any location, and using any device, ensuring the continuity of distance learning. To achieve this, educational institutions had to select video conferencing platforms that best suited their specific needs.

When analyzing Google Meet, it is worth noting its seamless integration with the Google Workspace environment. One of its main advantages is that it does not require installation on a Windows computer or laptop, as it runs directly in a browser window, although mobile applications are available for Android and iOS. Google Workspace integration enables the use of features such as a calendar (for scheduling meetings in advance), corporate email, office applications for document processing, and cloud storage. However, the functionality of Google Meet is limited in its free version, particularly in terms of the number of participants and meeting duration.

Given that higher education institutions often have access to corporate Microsoft accounts, their teachers and students may also utilize Microsoft Teams. This platform provides a convenient communication tool that supports both calls and text messaging (chats), which is a notable advantage over Google Meet. Since Teams is linked to a Microsoft account, users can also access Exchange email and OneDrive cloud storage. Additionally, the platform offers group creation functionalities that can be useful for organizing students into academic groups or faculties, thereby providing tools for managing large teams. A drawback of Teams is its relatively complex interface for new users and the need for configuration to fully utilize its capabilities.

On the other hand, Zoom is cross-platform and supports essential video and audio communication features, including tools designed to facilitate learning, such as an interactive whiteboard. Institutions also have the option to access an administrative Zoom account with extended capabilities, providing additional conference management features. Zoom stands out for its simplicity, high-quality data transmission, and global scalability. There are multiple ways to join a meeting, such as using a unique meeting ID and password or via a unique link that includes these credentials. The second option is more convenient as it eliminates the need to remember or record login details while ensuring that unauthorized users cannot access private meetings. The main advantage of Zoom over Google Meet and Microsoft Teams is its ease of use for large-scale online events, including webinars and conferences. Due to its intuitive design, Zoom is quickly adopted by new users, making it the optimal choice for educational institutions.

However, integrating such services into the existing infrastructure of higher education institutions is not always straightforward. Key challenges include the absence of centralized account management, a lack of automation in conference creation and administration, and the necessity of implementing robust data protection and privacy measures. These issues become even more pressing as the number of users and academic courses grows, increasing the need for an efficient and stable video conferencing management system.

Analysis of contemporary foreign and domestic research and publications

"Google Meet", "Microsoft Teams", and "Zoom" are among the most popular platforms for video conferencing, each offering distinct advantages [1]. The "Microsoft teams" is widely used by commercial organizations of various sizes and industries [2]. Examining the experience of using online meeting platforms reveals that for event registration and management, additional tools are often required. The most widely used solution for online conferencing in higher education institutions is Zoom platform [3–8]. The issue of interoperability between video conferencing systems and online educational platforms is particularly noticeable in cases where an educational institution operates its own digital environment, including electronic grade books, schedules, and internal documentation systems. Such systems may be based on open-source

solutions like Moodle or proprietary developments by leading universities and schools [9]. Given these considerations, it is essential not only to investigate existing video conferencing systems but also to develop solutions for integrating services like Zoom into educational platforms used by higher education institutions. This will enhance the organization of the learning process, improve student and faculty engagement, and ensure the stable operation of systems on a large scale [10].

Highlighting the previously unresolved aspects of the general problem to which the article is dedicated.

At the same time, it is necessary to conduct a more detailed and systematic examination of specific methodological and scientific-practical aspects related to the seamless and harmonious integration of video conferencing systems into the educational process. This includes, but is not limited to, evaluating the pedagogical implications of such integration, identifying the most effective instructional strategies for remote and hybrid learning environments, and ensuring that video conferencing tools align with established educational objectives and learning outcomes. A comprehensive analysis should also address the potential challenges teachers and students face when adapting to these technologies, such as digital literacy disparities, engagement fluctuations, and cognitive load management in virtual settings.

Furthermore, alongside the integration of video conferencing systems, special attention should be directed toward the exploration and development of novel methodological and technical approaches for assessing the overall effectiveness of the educational process. This entails the creation of robust assessment frameworks capable of capturing both qualitative and quantitative indicators of learning success, ensuring that students' progress is measured accurately in digital learning environments. The application of artificial intelligence, learning analytics, and data-driven decision-making techniques can play a crucial role in refining these assessment mechanisms, enabling real-time tracking of student engagement, participation levels, and comprehension rates.

In addition, it is vital to investigate the extent to which students grasp and internalize learning materials when instruction is delivered through video conferencing platforms. This requires the implementation of innovative evaluation methods, such as real-time adaptive assessments, automated

sentiment analysis, and interactive feedback systems, which can provide teachers with valuable insights into students' cognitive and emotional engagement. Moreover, interdisciplinary research should be conducted to examine how different instructional design models, including flipped classrooms, problem-based learning, and collaborative learning strategies, interact with video conferencing technologies to enhance student comprehension and knowledge retention.

Ultimately, achieving the optimal integration of video conferencing systems into the educational framework necessitates a multi-faceted approach that considers technological advancements, pedagogical best practices, and empirical research findings. By systematically addressing these critical aspects, educational institutions can ensure that remote and hybrid learning experiences are not only effective and engaging but also aligned with contemporary educational standards and future workforce demands.

Formulation of the research objectives

The goal of this research is to explore the integration of the Zoom platform with educational systems, focusing on the development of custom software solutions to optimize administrative processes, enhance educational interactions, and ensure secure and efficient use of video conferencing in the academic environment.

Problem Statement

In the context of integrating video conferencing technologies into the digital infrastructure of higher education institutions, the following key challenges must be addressed:

1. *Lack of centralized account and access management*

– Ensure unified authentication and user provisioning across institutional systems and conferencing platforms.

2. *Insufficient automation of scheduling and communication workflows*

– Streamline the creation, updating, and notification processes for online meetings within the educational process.

3. *Low degree of integration with existing learning management systems (LMS)*

– Develop solutions for seamless interoperability between conferencing tools and educational platforms to support consistent learning experiences.

4. *Limited pedagogical adaptability*

– Align conferencing technologies with instructional goals, active learning strategies, and student engagement models.

5. *Inadequate support for scalability and user-friendliness*

– Ensure the solution can support high usage loads while remaining accessible and intuitive for all stakeholders.

6. *Concerns about digital equity and accessibility*

– Address disparities in access to high-quality devices and internet connectivity among students and staff.

7. *Risks related to data privacy and institutional security*

– Implement privacy-by-design approaches and comply with educational data protection regulations (e.g., FERPA, GDPR).

This research aims to formulate a comprehensive methodology for overcoming these challenges through the pedagogically grounded integration of video conferencing systems into university digital ecosystems.

Presentation of the main material

The integration of video conferencing tools such as Zoom into the digital infrastructure of a university presents a transformative opportunity to enhance the efficiency and accessibility of the educational process. With the rapid advancement of online learning technologies, higher education institutions are increasingly leveraging Zoom to facilitate virtual lectures, interactive seminars, and collaborative learning experiences. This research examines the multifaceted benefits of Zoom integration, its compatibility with Learning Management Systems (LMS), interactive features that promote student engagement, security considerations, and the technical aspects of API-based customization to optimize the user experience.

Zoom serves as a powerful tool for the organization of online lectures and seminars, significantly improving interaction between teachers and students irrespective of their geographical location. This capability is particularly crucial for distance learning and hybrid teaching models, where some students attend classes in person while others participate online. By eliminating geographical constraints, Zoom enables universities to broaden their outreach, accommodating students from diverse backgrounds and facilitating international collaborations. The flexibility offered by Zoom is especially valuable for institutions with large numbers of students, as it allows for efficient course delivery without the limitations imposed by physical classroom capacities. Additionally, real-time video conferencing combined with screen-sharing functionalities enhances the ability of teachers to present complex concepts through multimedia resources, thereby improving students' comprehension.

Beyond its general applicability in higher education, lessons taken via Zoom have demonstrated particular relevance in crisis situations that disrupt traditional educational processes. The COVID-19 pandemic underscored the necessity of robust online learning platforms, as institutions worldwide were forced to shift to remote education almost instantaneously. During this period, Zoom emerged as a crucial facilitator of synchronous online learning, enabling teachers to maintain structured lesson plans and preserve the interactive dynamics of classroom instruction. Unlike asynchronous remote learning, which relies on independent study and delayed feedback, online learning via Zoom replicates real-time classroom experiences by allowing immediate engagement between students and teachers.

Moreover, in contexts of pandemia, martial law and political instability, online learning platforms such as Zoom provide essential continuity to educational programs. When physical attendance becomes infeasible due to security risks, universities can seamlessly transition to online formats without disrupting the academic calendar. This adaptability ensures that students continue receiving high-quality education despite adverse conditions. Additionally, the ability to record live sessions allows for content preservation, enabling students who may face connectivity issues to revisit materials at their convenience. The integration of Zoom with LMS further enhances its effectiveness by creating a comprehensive digital learning environment. LMS platforms such as Moodle, Blackboard, and Canvas provide essential functionalities such as assignment submissions, grading, and course material distribution. When combined with Zoom's synchronous interaction capabilities, these platforms create a cohesive educational ecosystem that supports both structured and flexible learning methodologies.

Furthermore, from a pedagogical perspective, Zoom facilitates innovative teaching methodologies, including flipped classrooms, collaborative group projects, and interactive workshops. The breakout room feature allows for small-group discussions, fostering peer-to-peer learning and encouraging active student participation. Additionally, the integration of artificial intelligence-driven analytics within Zoom provides teachers with data-driven insights into student engagement and performance, enabling personalized instructional strategies.

In further perspectives, the integration of Zoom with LMS platforms is able to transform the landscape of modern education, offering unprecedented adaptability and inclusivity. In crisis situations such as pandemics and martial law, its role becomes even more pronounced, ensuring that learning remains uninterrupted despite external disruptions. By leveraging the capabilities of synchronous online learning, educational institutions can not only mitigate the adverse effects of crises but also pave the way for a more resilient and globally connected academic environment.

One of the key aspects of Zoom integration is its seamless compatibility with widely used LMS platforms such as Moodle, Canvas, and Blackboard. This integration allows teachers to create Zoom meetings directly within their courses, ensuring that virtual sessions are embedded within the learning environment students interact with daily. Automated scheduling and synchronization features ensure that students receive timely notifications, reducing the likelihood of missed classes.

Furthermore, the ability to record lectures provides a significant advantage in terms of content retention and revision. Recorded sessions can be stored in the LMS's file storage and accessed by students for later review, allowing them to revisit complex topics and reinforce their understanding. This feature is particularly beneficial for students with varying learning paces, those with disabilities, or those who may have been unable to attend a live session due to time zone differences or technical issues.

An essential element of Zoom's success in education is its capacity to foster student engagement through interactive tools. Features such as chat, polls, and the "raise hand" function enable active participation, encouraging students to ask questions and engage in discussions even in a virtual setting. These features help bridge the gap between in-person and remote learning experiences, ensuring that students remain actively involved in the learning process.

Breakout Rooms serve as an additional engagement tool, allowing students to be divided into smaller groups for discussions, collaborative projects, and problem-solving activities. This functionality mimics traditional classroom group work, promoting teamwork and communication skills that are critical in higher education. Such interactive elements are instrumental in preventing disengagement, which is a common challenge in online education.

Ensuring the security and privacy of online classes is a fundamental concern for universities integrating Zoom into their digital environments. Zoom provides multiple security features, including waiting rooms, meeting passwords, and role-based access control, which help prevent unauthorized access and mitigate the risks of disruptions such as "Zoom bombing." Teachers have the ability to control participant permissions, restrict screen sharing, and manage breakout room assignments to maintain a secure and conducive learning environment.

Beyond session security, Zoom also complies with various international data protection regulations, including the General Data Protection Regulation (GDPR)[11] and the Family Educational Rights and Privacy Act (FERPA)[12]. This compliance is essential for universities that handle sensitive student data, ensuring that personal information is safeguarded against breaches. During times of martial law, such security measures become even more critical as digital surveillance and cybersecurity threats intensify. However, despite the implementation of stringent protections, students' learning experiences remain seamless, ensuring accessibility and ease of use without compromising security.

Another significant advantage of Zoom is its accessibility via mobile devices, including smartphones and tablets. This feature provides flexibility for students and teachers who may not have access to a desktop or laptop at all times. Mobile accessibility is particularly beneficial for students in remote areas or those who rely on mobile internet connections for online learning. During crisis situations, such as natural disasters, political unrest, or martial law, this capability becomes even more vital, ensuring uninterrupted education when traditional infrastructure may be compromised. Despite these challenges, Zoom maintains a user-friendly experience, allowing students to stay engaged in learning without additional technological burdens.

Furthermore, Zoom includes inclusivity features such as live captioning and real-time language translation, which enhance accessibility for students with hearing impairments and those studying in multilingual environments. These tools contribute to a more inclusive educational setting, ensuring that students with diverse needs can participate fully in the learning experience.

For optimal educational efficiency, Zoom should be integrated with the university's academic administration services. A common use case involves linking Zoom with the institution's

electronic scheduling system, which displays course schedules, teacher assignments, and venue details. In a remote learning context, the traditional classroom location is replaced with Zoom meeting credentials, including a multi-digit meeting ID and a secure password.

At present, teachers typically create Zoom meetings manually and insert the corresponding details into the university schedule. Students and faculty must then copy and input meeting credentials to join sessions. This manual process can be time-consuming and prone to errors. A more efficient approach involves automating this workflow through Zoom's API, which allows for the automatic generation and synchronization of meeting credentials within the university's digital environment.

Zoom provides an open Application Programming Interface (API) that enables institutions to develop custom applications for seamless integration. The Zoom for Developers resource offers comprehensive documentation on API functionalities, access control, and implementation guidelines. However, administrative rights and a paid institutional license are typically required to leverage these advanced features.

Through the Zoom API, universities can automate tasks such as:

- Automatically generating meeting links for scheduled classes;

- Embedding meeting details within the LMS;

- Tracking student attendance through API-driven reporting tools;

- Implementing authentication mechanisms to restrict unauthorized access;

For institutions utilizing open-source platforms, Zoom API integration can take the form of additional modules or plugins, allowing for a streamlined and user-friendly experience. Advanced configurations can also enable integration with university Single Sign-On (SSO) systems, ensuring that students and faculty can access Zoom meetings using their institutional credentials.

A prime example of an effective LMS is Moodle, one of the world's most widely used platforms for managing digital education. Moodle is renowned for its open-source nature and robust architecture, which allows extensive customization through plugin-based extensions. Among these extensions, the integration of Zoom stands out as a powerful tool that significantly enhances the effectiveness of distance learning by streamlining the organization of virtual sessions.

The incorporation of Zoom within Moodle simplifies the workflow for both teachers and students. Teachers can create, schedule, and manage online meetings directly from Moodle's interface without the need for manual session creation on Zoom's platform. This direct integration eliminates extra steps and potential scheduling conflicts, as all planned meetings are automatically synchronized with the Moodle course calendar. As a result, students receive timely notifications and can easily access meeting links, reducing the chances of missed sessions.

Beyond scheduling, the integration offers enhanced functionality for managing recorded lectures. Teachers can initiate Zoom lecture recordings, which are then automatically uploaded and published within the Moodle environment. This feature enables students to revisit missed sessions or review critical points at their convenience, fostering a more flexible and self-paced learning experience. The system also ensures controlled access to recorded materials, restricting viewing permissions to enrolled students only.

Additionally, Moodle's Zoom integration incorporates security measures to protect the integrity of virtual classrooms. Meeting access is strictly limited to students registered in the corresponding Moodle course, preventing unauthorized participants from joining. Teachers can further enhance interaction by utilizing Zoom's engagement features, such as polls, breakout rooms, and the "raise hand" function, which provide insights into student participation and comprehension.

From a technical standpoint, Moodle is primarily built using PHP, meaning its plugins are developed in the same language. The widely used third-party Zoom plugin, available on GitHub, provides the necessary functionalities for initiating and managing Zoom meetings within Moodle. The integration leverages Moodle's built-in authentication system to streamline security and user identification, ensuring that only authorized individuals gain access to meetings and related materials.

For successful Zoom integration, administrators have to install the designated plugin and configure it within Moodle's settings. This setup process requires entering authentication credentials generated during the Zoom application setup, including the Account ID, Client ID, and Client Secret. These credentials play a crucial role in establishing secure communication between Moodle and Zoom and must be stored securely to prevent unauthorized access, which could lead to data breaches or malicious activities.
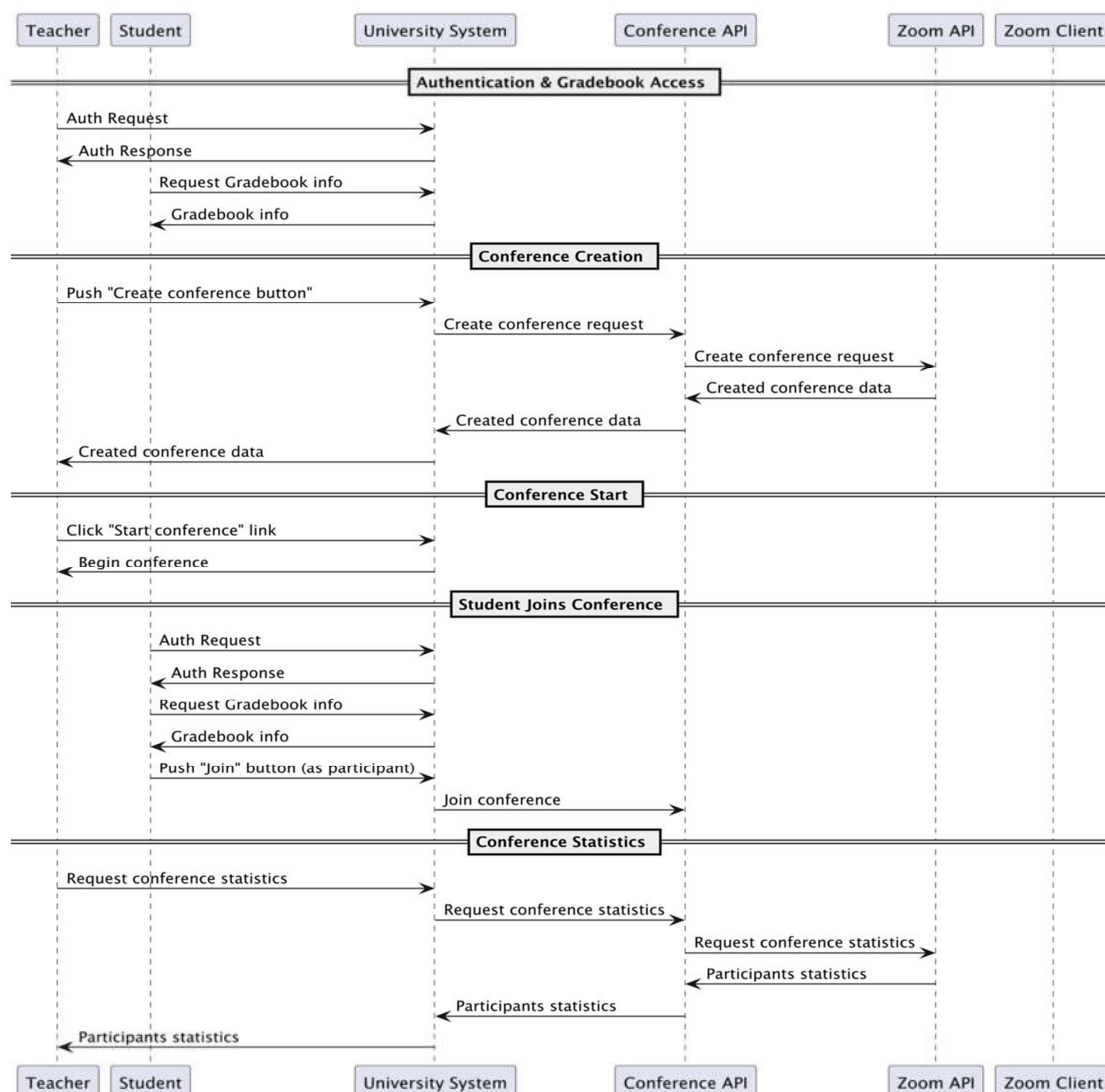
Figure 1 – Sequence diagram for service, that combines the university virtual learning environment with the Zoom Application Programming Interface

Once configured, teachers can create Zoom meetings directly from the Moodle interface. They can specify essential meeting parameters such as the meeting title, scheduled time, invited participants, and additional configurations like waiting rooms, microphone and camera settings, and participant restrictions. Upon completion of a session, teachers can access detailed attendance statistics, including information on participant entry and exit times, duration of attendance, and overall engagement.

Despite the numerous advantages of the Moodle Zoom plugin, there are inherent limitations. One major drawback is that the plugin requires an institution's system to be Moodle-based, restricting its cross-platform compatibility. Additionally, since the plugin relies on a graphical user interface (GUI), its adaptability to automated workflows and integration with non-Moodle environments remains limited.

To overcome these challenges, a more flexible alternative involves developing or implementing a dedicated background service that operates independently of a GUI. This service would function as an intermediary system capable of seamlessly integrating Zoom into the university's digital ecosystem, including its virtual learning environment. Unlike the traditional Moodle plugin approach, this solution would be compatible with both Linux and Windows environments and designed to consume minimal server resources while maintaining high operational efficiency. Given the scarcity of publicly available solutions for such integrations, developing a custom adapter tailored to the specific requirements of an educational institution emerges as the most viable approach. To structure this process effectively, a sequence diagram outlining the implementation workflow was presented (Figure 1).

A closer examination of the system's interaction process reveals that neither the teacher nor the student interacts directly with the newly developed integration service or the Zoom API. Instead, their engagement is limited to the university's software ecosystem and direct transitions to the Zoom application when necessary. The entire process of interfacing with the Zoom API and integrating it with the university's digital infrastructure is handled by the custom service, which serves as a bridge—or "adapter"—between two otherwise distinct software environments.

The interaction workflow begins when a teacher logs into the university's system, navigates to the course management module, and selects the option to create a Zoom conference. This request is intercepted by the adapter service, which establishes a secure connection with the Zoom API. The adapter then formats the request according to the required parameters, transmits it to Zoom, receives a response, and relays the generated conference details—such as the meeting start link for teachers and the join link for students—back to the university's system. As a result, the teacher can conveniently access and manage all session links through the course management interface, while students, upon logging into their Moodle dashboard, can view and join scheduled meetings with a single click.

A key advantage of this approach is the automatic assignment of participant roles within the session. Unlike manual role assignments, where users must be individually designated as hosts, co-hosts, or participants, the integration service can dynamically classify users based on their system credentials. This automated role distribution streamlines administrative efforts and contributes to the generation of accurate attendance reports.

Once a session concludes, the teacher can return to the university's system to review session statistics. The collected data includes detailed attendance records, tracking when students joined and left the session and their overall participation duration. These analytics not only assist in monitoring attendance but also provide valuable insights into student engagement levels. By analyzing these participation metrics, teachers can assess the effectiveness of various teaching methodologies and make data-driven improvements to their instructional strategies, ultimately enhancing the quality of education.

In summary, while Moodle's native Zoom integration offers a convenient solution for conducting online classes, its reliance on a plugin-based approach presents limitations in terms of adaptability and scalability. By implementing a dedicated background service, universities can achieve greater flexibility, enhanced security, and seamless integration within their digital learning environments. This approach ensures a more efficient and robust online learning infrastructure, aligning with the evolving demands of modern education.

It is also important to note that the statistical functionality for a given conference cannot operate correctly without proper configuration of the Zoom account on which the Zoom application is based and whose credentials are used to obtain the Zoom API access token (commonly referred to as the Zoom Auth token). According to the official Zoom documentation, in order to provide full functionality for a specific group of users—namely, students and university staff—it is necessary to add all email addresses of faculty members, teachers, and students to the administrator account settings in Zoom. Since higher education institutions typically use a unified corporate account system (e.g., Microsoft or Google accounts), this significantly simplifies the process—one only needs to retrieve all active email addresses, add them to the list, and update these lists annually during summer and winter breaks by removing inactive accounts and adding new ones in a timely manner. Failure to perform this process may result in missing user email addresses in statistical reports, making it impossible to identify individuals and distinguish the statistical data of different users.

Conclusions

The conducted analysis highlights both the technical potential and the pedagogical significance of integrating video conferencing tools—specifically Zoom—into the digital infrastructure of higher education institutions. Based on the study's findings, the following conclusions can be drawn:

1. The choice of a video conferencing system should be based on the specific characteristics of an educational institution, including its scale, technical and financial resources, and organizational readiness for digital transformation. Zoom is currently one of the most widely adopted platforms due to its cross-platform compatibility, user-friendly interface, and comprehensive set of features for online interaction.

2. The availability of an open Zoom API provides significant opportunities for the development of customized integration solutions.

This makes it possible to create adaptive software tools (e.g., background services) that enable seamless data exchange between institutional systems and the Zoom platform, enhancing the efficiency of managing online meetings.

3. Further research should focus on analyzing the structural and functional characteristics of university digital ecosystems, with the aim of designing, implementing, and testing a specialized service that integrates the Zoom API. Such a service should improve the management of online conferences and simplify access for all participants in the educational process.

4. Beyond technical implementation, the social and pedagogical dimensions of video conferencing integration require careful consideration. Zoom-based solutions strengthen communication between teachers and students, support distance learning formats, and contribute to educational inclusion for students with disabilities or those in remote areas.

5. The integration of video conferencing systems also presents organizational and infrastructural challenges. Successful implementation requires investment in staff training, technical support, and the development of stable infrastructure to ensure high-quality video transmission and system performance.

6. Data protection and privacy remain critical issues in the context of Zoom integration. Future work should prioritize the analysis of encryption protocols, access control mechanisms, and regulatory compliance (e.g., GDPR, FERPA) to safeguard the confidentiality and security of student and faculty data.

Perspectives for further research should focus on several key areas:

1. Integration with Other Educational Systems: Future studies could investigate the development of more advanced integrations between Zoom and other educational technologies, such as different Learning Management Systems, virtual classrooms, and assessment tools, to create a seamless and comprehensive digital learning environment.

2. Optimization of Conference Management: Further research should explore the development and testing of services that enhance Zoom's conference management capabilities within the academic context. This could include automated features for scheduling, attendee tracking, and resource sharing during online sessions.

3. Social and Pedagogical Implications: There is potential for research into the social and pedagogical effects of Zoom integration in higher education. This could involve analyzing its impact on student engagement, participation, and learning outcomes, especially in different cultural and educational settings.

4. Challenges in System Implementation: Further research could address the technical and organizational challenges related to the implementation of Zoom and similar systems in higher education. This includes the study of cost-benefit analysis, resource allocation, and the scalability of such systems across different types of institutions.

5. Security and Privacy Enhancements: Future work should focus on strengthening security and privacy measures, particularly in relation to protecting sensitive academic and personal data during online interactions. This could include the exploration of more robust encryption protocols, secure authentication methods, and tools for monitoring and preventing cyber threats.

6. Training and Support: Research could also explore the best practices for training staff and students to effectively use online conferencing tools. This includes investigating the creation of scalable training programs, support structures, and resources to ensure smooth adoption and usage.

By addressing these research directions, future studies can contribute to the continued improvement and optimization of online learning environments, ensuring that they meet the evolving needs of both educational institutions and students.

In conclusion, the integration of Zoom into an educational institution's learning environment not only opens new opportunities for improving the educational process but also raises questions regarding the further modernization of digital infrastructure in higher education. Online learning systems that utilize tools such as Zoom contribute to the creation of a more adaptive, flexible, and inclusive virtual learning environment that meets the challenges of contemporary education.

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ІНТЕГРАЦІЯ ВІРТУАЛЬНОГО ОСВІТНЬОГО СЕРЕДОВИЩА УНІВЕРСИТЕТУ ІЗ СЕРВІСОМ ZOOM

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Анотація. У даному дослідженні розглядаються найбільш поширені системи для онлайн-зустрічей, аналізуються їхні переваги та недоліки, а також обґрунтовується вибір платформи Zoom як основи для організації освітнього процесу в умовах цифрової трансформації. Особливу увагу приділено гнучкості, масштабованості та доступності Zoom, що робить її придатною для широкого спектра освітніх сценаріїв – від звичайних лекцій до інтерактивних семінарів і групових проектів. Робота досліджує інтеграцію Zoom із популярними системами управління навчанням, зокрема Moodle, Google Classroom, Microsoft Teams та іншими, а також розробку незалежних адаптерних сервісів для об'єднання університетського освітнього програмного забезпечення та платформ відеоконференцій. У ході дослідження уточнено структуру розширеної інформаційної системи закладу вищої освіти, включаючи її взаємодію із серверами та клієнтами Zoom, а також із внутрішніми ІТ-сервісами. Проаналізовано переваги адаптації Zoom до специфічних потреб університетів, зокрема розробку користувацьких інтеграцій для підключення внутрішніх систем управління навчанням, електронних журналів, модулів оцінювання, розкладів та інших сервісів, що використовуються в освітньому середовищі. Така інтеграція сприяє оптимізації адміністративних процесів, полегшенню роботи викладачів, автоматизації рутинних завдань та забезпеченню зручного доступу студентів до навчальних матеріалів у синхронному та асинхронному режимах. Окремо розглядаються питання безпеки та захисту даних при використанні Zoom у навчальних цілях. Детально проаналізовано механізми забезпечення конфіденційності та надійності системи, зокрема функції аутентифікації користувачів, багаторівневе шифрування даних, захищені канали зв'язку та адміністрування доступу до навчальних сесій. У підсумку зроблено висновки щодо впливу інтеграції Zoom на підвищення якості, гнучкості та доступності освіти в умовах глобалізації, цифровізації та викликів, пов'язаних з кризовими ситуаціями у сфері освіти.

Ключові слова: відео конференції; Zoom; дистанційне навчання; Moodle; цифровий університетський простір.