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PRACTICAL IMPLEMENTATION OF THE BYOD CONCEPT IN HIGHER EDUCATIONAL INSTITUTIONS

Abstract. The emerging range of personal mobile devices, due to their advanced technical characteristics, has made it possible to widely use them at enterprises, offices or educational institutions almost in any place. This has led to the introduction of a new concept of BYOD (Bring Your Own Device), when a personal device (phone, tablet) is used for work or study. One of the serious problems encountered by teachers on the way of implementing BYOD into the educational process is the insufficient level of information competence and the lack of educational manuals for such classes. The aim of the research is to investigate the relevance of implementing BYOD approach in teaching Computer Engineering students and to consider the possibilities of using mobile devices for didactic purposes directly in the classroom and in distance learning. Within BYOD, the use of learning support mobile systems in the learning process gives its participants access to training materials, services and models adapted for the use in a mobile environment. The teachers effectively manage the learning process, in particular, focus the students' attention on the sources of information that give the most correct and complete answers within the relevant disciplines. The research presents learning outcomes of two groups: control, with the traditional method of teaching and the equipment provided by the educational institution, and experimental, when students use their own mobile devices (tablets and smartphones) in the educational process, which gives a possibility to learn in any place convenient for a student and remotely send progress reports. The results showed that the students of the experimental group outperformed their groupmates from the control group in academic progress. The implementation of BYOD elements has led to the increase in students' motivation and interest in their own learning. The main positive aspects of using BYOD technology in the learning process have been identified, such as convenience and flexibility, reducing the expenses of educational institutions, simplifying work with the network services, interactivity of learning, and applying multimedia format in the presentation of educational material during lectures, laboratory and practical classes, effectiveness of work with information and the presentation of results.

Keywords: mobile learning; tablet; smartphone; mobile application; quality of education; education.

1. INTRODUCTION

The problem statement. The teaching job in a modern higher educational institution requires a quick adaption of a teacher to rapidly changing and emerging technologies, to the change of the environment from which the students and the staff of educational institutions receive information. The abundance of information sources and electronic devices contributes to increasing students' internal freedom and development of a critical attitude to the knowledge acquired. It is information and communication competence, both general and professional, that plays a significant role when educating specialists in educational institutions.

The introduction of a range of mobile devices (laptops, tablets, smartphones), which can be successfully used at home, at work or in an educational institution thanks to their high (and constantly improving) technical characteristics, has led to the introduction of a new BYOD technology (Bring Your Own Device), which involves working with a smart phone or tablet that combines a textbook, notebook and communicator. At the beginning of this century, the share of the students who brought their laptops to classes barely reached 10%, but now, according to our observations, this indicator is approaching 100%. It is impossible to "involve" mobile devices in the learning process by simply connecting these devices to the computer network of the educational institution. Fortunately, business has already addressed this problem, so some experience of using mobile devices at business enterprises has been gained. Teachers also have to accept this challenge and add new technologies to the learning process.

Analysis of recent studies and publications. In scientific literature, learning across multiple contexts, through social and content interactions, using personal electronic devices is called mobile learning (M-Learning). The theoretical aspects of mobile learning have repeatedly been reflected in the writings of both national and foreign researchers. M. Ally in [1] suggests that mobile learning changes the entire educational process, since the use of mobile devices modifies not only the forms of presentation and access to it, but also contributes to the creation of new forms of cognition and mentality. In [2] a comparison of mobile, electronic and traditional learning was carried out, and it was noted that the development of modern methods for implementing M-learning technologies in educational institutions of different levels of accreditation is prospective in Ukraine.

The issues of mobile learning in general and the BYOD concept in particular have been raised in recent years by S.O.Semerikov, V.M. Andrievskaya and L.I. Belousova, F. Ya. Maynaeva, R.Afreen and others [3-11].

BYOD technology helps students to perceive various technical means and the Internet as the tools necessary to meet cognitive needs and solve learning problems. One of the serious problems encountered by teachers on the way of implementing BYOD is the insufficient level of information competence and the lack of guidelines for such classes.

The purpose of the article. The aim of this paper is to propose a new approach to conducting classes for Computer Engineering students and consider the possibility of using mobile devices for didactic purposes directly in the classroom and in distance learning.

2. THEORETICAL BACKGROUND

Within the BYOD concept, there are several approaches that partially address the issues of the student and teacher interaction, as well as the use of special purpose software.

This is BYOD itself, when a student comes with his/her mobile equipment, and the teacher's task is to offer him/her special purpose software from that available for performing

tasks on the subject, to propose the organization of storage of current results and ways of communicating with the student during performance of the work and reporting on its results.

Some educational institutions use CYOD technology (Choose Your Own Device), the main feature of which is that the educational institution provides students with mobile devices for temporary use (usually during the lesson). In this case, installing the necessary software, concluding a contract for the provision of communication services and other necessary technical aspects of conducting laboratory and practical classes are the responsibility of the educational institution.

If BYOD technology requires certain costs for purchasing and maintenance of a student's own mobile device, in case of CYOD technology, the entire cost falls directly on the institution.

We consider as a prospective direction the option of the shared use of these technologies, where the educational institution provides mobile devices to a limited group of students who do not have mobile devices with the necessary technical capabilities complying with the requirements of the software.

Within BYOD technology, the use of Mobile Learning Management System (MLMS, MSPN) in the learning process allows students to gain controlled access to teaching materials, and the teachers to manage the learning process and check its effectiveness. MLMS is a platform through which mobile access to training materials, services and models adapted for the use in a mobile environment is provided. [3]

When using mobile devices in learning, the following useful opportunities open [3-5]:

- instant recording of results, stages (dynamics) of work by creating sequential screenshots or sequences of frames, creating interactive presentations (PowToon, Prezi), for example, from YouTube channel or one's own video, with the ability to crop a screenshot, add text, graphics;

- access to the Internet resources (video, graphics, text documents, maps, dictionaries) necessary for work in the classroom;

- convenient creation of videos, photos that are automatically uploaded to a secure cloud storage, get organized and become available for search immediately after downloading in full confidentiality;

- convenient processing of videos, photos thanks to advanced filtering functions, the presence of convenient tools for adding text on photos and videos, and many other opportunities;

- scanning of QR code (Quick Response), which facilitates free access to the sources of information (video, audio, websites, etc.);

- easy creation of one's own QR code (for example, for e-mail, phone number or any information) and its distribution, if necessary, via social networking services (Facebook, Twitter and others) among the participants in communication. The QR code, acting as a hyperlink, can be useful if it is necessary to give an important information or simplify its use by others;

- access to electronic maps in the mode of a schematic or satellite map with the ability to automatically search for objects, instantly find one's own or desired place, GPS navigation, other geo-information, etc.;

- access to electronic dictionaries, encyclopedias and other web-resources;

- creating, editing and / or viewing of joint documents, spreadsheets online;

- the use of multifunctional educational applications that allow creating online projects in academic disciplines with the ability to test their performance in the cloud;

- creation of a common information and educational digital space for organizing high-quality group work, in particular, open online commenting on work, maintaining a history of interaction, etc.;

- online cooperation with members of the group or project, regardless of geographical location, conducting webinars, quick interaction between the teacher and the student through quick messages (Viber, Telegram, Skype, WhatsApp, etc.);

- implementation of operative communication through online-inquiry in real time mode;

- the functions of an audio/video player and voice recorder can be used to record and reproduce the presentation of theoretical material given by the teacher in a lecture.

BYOD technology has become an element of the information and didactic system of educational institutions, which allows considering the process of teaching students as an information process in which information is received, collected, processed and used with the help of mobile information and communication tools. Using the search system, a student easily gets the necessary information in response to the formulated queries. The teacher's task is to focus the student's attention on information sources giving the most correct and complete answers within the framework of the relevant disciplines.

As a learning management system (LMS), a course management system (CMS), a virtual learning environment (VLE), and above all, as a platform for organization of interaction between the teacher and students, educational institutions of Ukraine, as a rule, use the Moodle (Modular Object-Oriented Dynamic Learning Environment), but, unfortunately, there is no mobile version of this system.

As an alternative to this system, Google Classroom, a free web service with an application for smartphones (iOS, Android), is of interest. Google Classroom was created specifically for educational institutions as a learning management system and is suitable for organizing distance learning courses and supporting traditional full-time study. A private code, which can be used by the students to join the group (class) or choose the subject for study, is created for each class (group), while a separate office and electronic documents for communication with the teacher are created for each student. In general, Google Classroom allows carrying out asynchronous and synchronous learning, mixed learning, has a built-in calendar and an internal messaging system, allows teachers to create lectures and practical courses, tests, assign and check assignments, and show student statistics.

The easiest way to use mobile phones and tablets in the learning process is the use of QR codes to give students a variety of information in a convenient compact form [12]. The information obtained using the QR code can act as the main material provided to students for mastering the course (lecture notes, educational manuals for practical, laboratory studies, course projects, etc.), as well as additional material allowing students to more easily adapt to the subject and receive auxiliary information (for example, links to various sites and forums on subjects, online seminars and lectures, as well as teacher's additional presentations not included in the lecture course).

In [13] a method for conducting a frontal assessment of students with the help of mobile phone using the Plickers service was proposed. A mobile application, a service site and printed cards with QR codes form the basis of this method. Each student is assigned a unique Plickers card and holding up the card determines the student's choice of one of the four possible answers. This method allows quick assessing of knowledge of the entire group at the same time. The recognition program records all cards turned up, and the results of responses for each student are immediately entered into the database. Any interested person, a teacher or a student, can find out the number of correct answers at any given time. This approach was successfully implemented by the author [13] when teaching the disciplines "Cryptographic Tools and Methods of Information Protection" and "Fundamentals of Programming and Databases".

It is recommended to use the following mobile applications for organizing the educational process: Blicher Bluetooth For Students (a classroom response system that uses

Bluetooth Low Energy for the student and the teacher interaction and does not need Internet connection), Kahoot! (a free game-based learning platform for administering quizzes, discussions and surveys), PollEverywhere (an online service for classroom response systems).

It is possible to make full use of camera functions in laboratory work in the Computer Graphics course to get primary images or video sequences for further processing, where mobile versions of well-known developers of graphic editors Photoshop Express, Photoshop Mix, Lightroom and Adobe Photoshop Sketch from Adobe, PhotoDirector and ActioDirector Video Editr from CyberLink and others can be used.

The use of tablets and mobile phones with various operating systems in the Linux System Administration course was described in [14]. The experiments conducted indicate the possibility of successful use of the entire spectrum of mobile workstations with a single set of applied software distributed by a free license.

Despite the fact that the processors of mobile devices have lower capacity than the processors of PCs and laptops, their RAM is much smaller and high speed response is inferior to desktop PCs, they have an undeniable advantage, namely the opportunity to be used at any time, anywhere, “on the go”. Modern mobile applications, although inferior in capabilities to programs written for PC (desktop applications), still make it possible not only to gain knowledge through various reference programs, but also to acquire skills in designing programs and systems. The future development of the power of mobile devices and the widespread use of cloud applications will only bring the quality of programs and services closer to the users’ needs.

Using the methodology proposed by Ammar H. Safar in [15], in the course of teaching several subjects for Computer Engineering students the research with two groups of students was conducted: an experimental (BYOD) group and a control (not BYOD) group. The experimental group used their own mobile devices (tablets and smartphones), while the control group used traditional teaching aids (desktop PCs and laboratory benches provided by the University, language laboratories, etc.).

To complete tasks, prepare for classes and independent work on disciplines involved in the research, the students of the experimental group had to choose from the set of applications proposed by the teacher those that were the most suitable for them.

The following applications have been used in the course of study of programming-related disciplines.

C Programming Reference FREE is a set of free cheat sheets for C/C++ learners, a complete reference on C++ programming, starting with brief reference data and ending with educational manuals on the programming language.

DroidEdit is a text and source code editor for Android devices, with syntax highlighting for several languages (C, C++, C #, Java, HTML, CSS, Javascript, Python, Ruby, Lua, LaTeX, SQL), searching and replacing, with the possibility of using various encodings.

SoloLearn is the largest collection of free programming study materials for users of various skill levels. The concept of the project is to actively replenish the content. It helps to learn the basics, sharpen skills and keep abreast of the latest programming trends, including the languages Python, Java, Kotlin, C ++, C, C#, PHP, SQL, Ruby, Swift.

Application “Learn Programming” is an interactive textbook of Internet technologies. It supports more than 35 programming languages (including C, C#, C++, CSS, Java, Pascal, Perl, Php, Python, Ruby, SQL, Swift, VBScript). There are tests that are evaluated in the form of statistical tables, the ability to write code that automatically displays in the browser.

Programming Hub: Learn to code is an application for learning programming. It has a collection of 5000+ programs (code examples), more than 35 courses, it is equipped with a fast compiler with support for compilation and work in more than 20 programming languages. There is the possibility of learning Java, C, C++, etc.

C4droid is a standalone compiler of C/C++, IDE C/C++ for Android, which gives a possibility to create your own applications on an Android device and run them even without Internet access. It is a source code editor with syntax highlighting, tabs, code completion, code formatting, file association and undo / redo.

The study of disciplines related to hardware of the computer systems, networks and computer electronics is supported by the following applications.

EveryCircuit is a computer simulator that allows simulating the operation of a small electronic circuit. Functionally, the simulator works with SPICE-models of radio elements. A distinctive feature of the system is the ability to work on all types of computing tools: on a PC (in the Chrome browser), Android devices and iOS devices.

Droid Tesla is a simple and powerful circuit SPICE-simulator. In addition to the radio components, various current and voltage sources are supported, as well as the main measuring instruments (AC/DC ammeter and voltmeter, 2-channel virtual oscilloscope). Emulation of the following electronic components: resistor; capacitor; inductor; potentiometer; light bulb; ideal operational amplifier; bipolar junction transistor; MOSFET transformer; diode, LED and zener diode; switches; elements of digital logic: AND, NAND, OR, NOR, NOT, XOR, XNOR; triggers 555-timer; relay; 7 segment display, and others is supported.

ElectroDroid and ElectroDroid PRO are large electronic directories of electronic components, as well as pinouts of various computer interfaces.

In addition to numerous and varied reference books, emulators and microprocessor design systems are of particular interest.

For programming micro controllers and microprocessor devices, it is proposed to use AVR Droid IDE, Arduino Droid IDE. For programming AVR, the ZFlasher AVR application is useful, which can be used not only in practical studies, but also for quick flashing of microprocessors “in the field”. CoderBro's Electronic Projects application has pre-built projects with diagrams and codes and will allow students to create devices outside the classroom.

Arduino Commander and Sketchware for Arduino - The Arduino Coding App allow controlling Arduino using a block programming language.

The Arduino IDE application is designed to create and edit sketches for Arduino using an Android device.

The Microcontroller programs application is convenient for teaching controller programming. The application provides working codes and circuits of microprocessor systems, which helps to master the basics of programming of micro controllers.

For studying the disciplines associated with the design of computer devices, the following applications can be distinguished.

The well-established applications for creating 3D models are the applications “Free 3D CAD-CAD Modeler Modeling” from Wuweido, Autodesk SketchBook and Fusion 360 from Autodesk inc, Prisma3D - 3D Modeling, Animation, Rendering from Prisma3D. There are other modeling programs using a smart phone or tablet that are compatible not only with each other, but also with computer analogues of 3D modeling programs.

The PCB Droid application can be recommended for wiring boards.

Neuronify App from Ovilab allows working on neural modeling without prior computing experience.

With regard to providing mobile applications for computer network related disciplines, Cisco Systems, Inc., a leading computer network hardware and software company, offers a series of mobile applications for training with its equipment: Cisco Network Setup Assistant, CCNA Simple Commands, E-Service Training, Cisco dCloud, etc., among which we can distinguish Cisco Packet Tracer Mobile, which allows creating networks and simulating their work.

As to learning Foreign Language, there are lots of mobile applications, such as Duolingo, Memrise, Lingua.ly, LearnEnglish Grammar, Johnny Grammar's WordChallenge, SpeakingPal EnglishTutor, MyWordBook 2, Busuu, Fun Easy Learn English, Phrasalstein.

Learn English Grammar is an interactive application that can be used to practise and improve accuracy in English grammar. It covers 12 grammar topics with 20 activities per topic for English learners of all levels.

But the most popular application among IT students is a mobile version of British Council resources such as LearnEnglish. The following programs: 6 Minute English, English at Work, The English We Speak help to improve and develop listening, speaking and reading skills through topical new stories.

Another broad-based mobile application group for teachers and students is vocabulary applications. Among the famous ones are Reverse English, 15500 Useful English Phrases, WordBook–English Dictionary & Thesaurus, Advanced English Dictionary & Thesaurus. With the help of these applications, IT students enrich their language with a variety of business phrases, public speaking phrases, and specific purpose vocabulary with high quality audio pronunciation.

3. THE RESULTS AND DISCUSSION

To assess the impact of BYOD on the educational process, the experiment was held at the Department of Information Technologies of Kherson National Technical University, Ukraine.

20 students majoring in Computer Engineering took part in the experiment, and the following disciplines of the professional training cycle were involved: Computer Networks, Programming, Computer Electronics and Circuitry, as well as Foreign Language, a discipline of the general training cycle (as one of the most important supporting disciplines for IT specialties). Students were divided into two groups (the control and the experimental) with the same number of students (10 people each). The experimental group was provided with opportunities to learn with various electronic resources and to interact with groupmates and teachers using their own devices in class, while the control group was not.

Data were collected during the semester and took the form of various indicators: test results, assignment scores, and final grades. The results of testing students and their final grades in the course were used as the main criterion. Assessment was carried out on a 100-point ECTS scale.

The influence of applying BYOD method on the performance of undergraduate students at the end of each course was examined. The Google Classroom service was used for the current monitoring of student performance in the experimental group (check and defence of laboratory work, current quick tests, etc.).

Having analyzed the results, we concluded that the performance indicators in the experimental group (BYOD) compared with the control group for the disciplines involved in the experiment changed as follows:

- a) Foreign Language:
 - the quality of knowledge (share of students who scored 74-100 points) in the experimental group was 15% higher than in the control group;
- b) Computer Networks:
 - the quality of knowledge in the experimental group was 10% higher than in the control group;
- c) Programming:
 - the quality of knowledge in the experimental group was 15% higher than in the control group;

d) Computer Electronics and Circuitry:

- the quality of knowledge in the experimental group was 5% higher than in the control group.

Thus, there is a clear correlation between the learning process with the use of BYOD technology and students' performance. The results are shown in Fig.1.

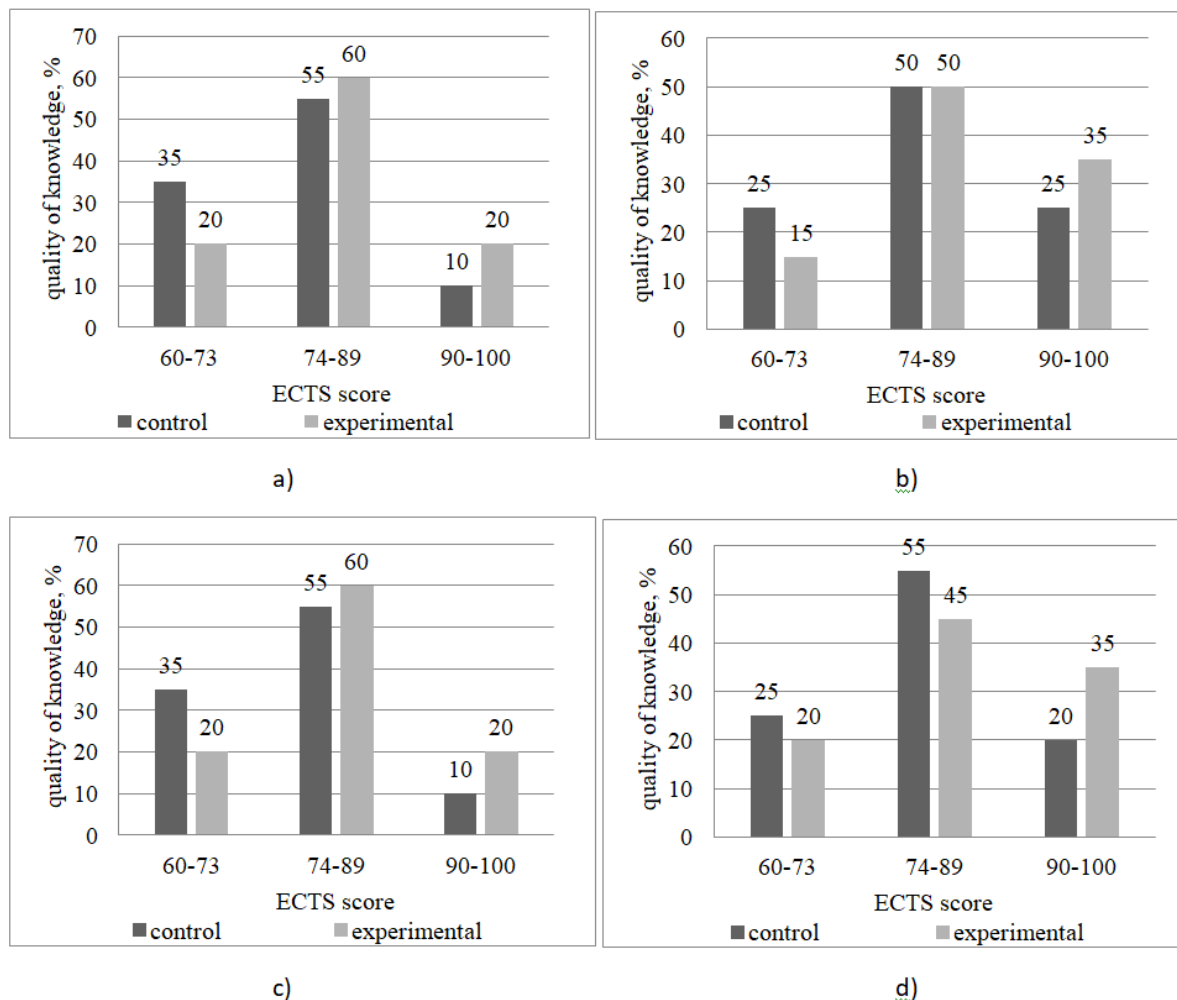


Figure 1. Qualitative indicators of students' progress in disciplines a) foreign language, b) computer networks c) programming d) computer electronics and circuitry

An analysis of the results of this research shows that the implementation of BYOD technology in learning process has had a significant positive impact on student performance. In particular, it has led to the following consequences: the increase in students' motivation and interest in their own learning, which ultimately has led to the improved results. In addition, the data of this study are consistent with the results of other similar studies conducted over the past decade [15].

4. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

The main positive aspects of using BYOD technology in learning are convenience and flexibility, reducing expenses of educational institutions, simplifying work with the network services, interactivity of learning, and applying multimedia format in the presentation of

educational material in lectures, laboratory and practical classes, effectiveness of work with information and the presentation of results. Mobile technologies are becoming more widespread in the educational process, and with the expansion of the functionality of mobile devices, the possibilities of their use in education will grow. However, it should be noted that there is a complete lack of mobile applications for the study, design and programming of computer systems and devices from Ukrainian developers, as well as those supporting the Ukrainian language.

Directions for further research are to develop teaching goals using mobile devices, the implementation of which will contribute to the intellectual development of students, preparing them for future professional activities.

This research has provided empirical evidence of the effectiveness and relevance of the BYOD concept for increasing the efficiency of teaching and improving students' learning outcomes. Nevertheless, a number of open issues remain, in particular:

1. Successful implementation of BYOD requires a teacher to be creative, and it is advisable to try to formalize the requirements to the support of a new methodology.
2. The deployment of the BYOD program in any organization requires attention to many factors, including security issues that have to be investigated more thoroughly in the future.

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ПРАКТИЧНА РЕАЛІЗАЦІЯ КОНЦЕПЦІЇ BYOD У ЗАКЛАДАХ ВИЩОЇ ОСВІТИ

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Анотація. Поява широкого спектра мобільних пристроїв індивідуального користування призвела до того, що завдяки їхнім високим технічним характеристикам, роботу, виконувану на підприємствах, офісах або в навчальних закладах, за їхньою допомогою стало можливим робити практично в будь-якому місці. Це спричинило виникнення нової концепції BYOD (Bring Your Own Device – принеси свій власний пристрій), коли особистий пристрій (телефон, планшет) використовується для роботи або навчання. Одна із серйозних проблем, що стоять перед викладачем на шляху впровадження BYOD у навчальний процес, - недостатній рівень інформаційної компетентності й відсутність методичних рекомендацій для проведення таких навчальних занять. У роботі було поставлено дослідити доцільність

використання концепції BYOD у навчанні студентів спеціальності «Комп'ютерна інженерія», розглянути можливості застосування мобільних пристроїв у дидактичних цілях безпосередньо на аудиторних заняттях і при дистанційному навчанні. У рамках BYOD використання в процесі навчання мобільних систем підтримки навчання дає його учасникам доступ до навчальних матеріалів, послуг і моделей, адаптованих для використання в мобільному середовищі. У викладачів з'являється можливість ефективно управляти процесом навчання, зокрема, фокусувати увагу студента на джерелах інформації, що дають найбільш правильні й повні відповіді у рамках відповідних дисциплін. У роботі наведені результати навчання двох груп: традиційної, з устояною методикою навчання й устаткуванням, надаваним навчальним закладом, і експериментальної, яка використовує в навчальному процесі власні мобільні пристрої (планшети й смартфони), що дають можливість виконувати поставлені завдання в будь-якому зручному студентів місці й віддалено надавати звіти про виконану роботу. Результати показали, що студенти експериментальної групи перевершили своїх колег у контрольній групі по успішності. Впровадження елементів BYOD спричинило зростання вмотивованості студентів, зацікавленості їх в участі у власному навчанні. До основних позитивних аспектів використання технології BYOD у навчальному процесі можна віднести зручність і гнучкість, зниження витрат навчальних закладів, спрощення роботи з мережними сервісами, інтерактивність навчання й мультимедійний формат подання матеріалів дисциплін (лекційного курсу, лабораторних і практичних занять), оперативність роботи з інформацією й представлення результатів.

Ключові слова: мобільне навчання; планшет; смартфон; мобільний додаток; якість навчання; освіта.

ПРАКТИЧЕСКАЯ РЕАЛИЗАЦИЯ КОНЦЕПЦИИ BYOD В ВЫСШИХ УЧЕБНЫХ ЗАВЕДЕНИЯХ

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Аннотация. Появление широкого спектра мобильных устройств индивидуального пользования привело к тому, что благодаря их высоким техническим характеристикам, работу, выполняемую на предприятиях, офисах или в учебных заведениях, с их помощью стало возможным делать практически в любом месте. Это вызвало возникновение новой концепции BYOD (Bring Your Own Device – принеси свое собственное устройство), когда личное устройство (телефон, планшет) используется для работы или обучения. Одна из серьезных проблем, которые стоят перед преподавателем на пути внедрения BYOD в учебный процесс, - недостаточный уровень информационной компетентности и отсутствие

методических рекомендаций для проведения таких учебных занятий. В работе была поставлена задача исследовать целесообразность внедрения BYOD подхода в обучении студентов специальности «Компьютерная инженерия», рассмотреть возможности применения мобильных устройств в дидактических целях непосредственно на аудиторных занятиях и при дистанционном обучении. В рамках BYOD использование в процессе обучения мобильных систем поддержки обучения дает его участникам доступ к учебным материалам, услугам и моделям, адаптированным для использования в мобильной среде. У преподавателей появляется возможность эффективно управлять процессом обучения, в частности, фокусировать внимание студента на источниках информации, которые дают наиболее правильные и полные ответы в рамках соответствующих дисциплин. В работе приведены результаты обучения двух групп: традиционной, с устоявшейся методикой обучения и оборудованием, предоставленным учебным заведением, и экспериментальной, которая использует в учебном процессе собственные мобильные устройства студентов (планшеты и смартфоны), которые дают возможность выполнять поставленные задачи в любом удобном студенту месте и удаленно предоставлять отчеты о выполненной работе. Результаты показали, что студенты экспериментальной группы превзошли своих коллег в контрольной группе по успеваемости. Внедрение элементов BYOD привело к росту мотивированности студентов, заинтересованности их в участии в собственном обучении. К основным положительным аспектам использования технологии BYOD в учебном процессе можно отнести удобство и гибкость, снижение затрат учебных заведений, упрощение работы с сетевыми сервисами, интерактивность обучения и мультимедийный формат представления материалов дисциплин (лекционного курса, лабораторных и практических занятий), оперативность работы с информацией и представления результатов.

Ключевые слова: мобильное обучение; планшет; смартфон; мобильное приложение; качество обучения; образование.

