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THE USE OF QR-CODES IN PROFESSIONAL TRAINING OF STUDENTS OF ENVIRONMENTAL AND EDUCATIONAL INDUSTRIES

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The article emphasizes the significance of the information and digital competence of teachers, which includes the ability to navigate in the information and digital space, the search and critical analysis of information, the use of educational electronic resources and creation of new ones, the use of digital technologies in the educational process. It notes that Digital Competence of Educators the European framework identifies six main areas of application: professional involvement; digital resources; teaching and learning; evaluation; promoting students' digital competence.

The article reveals the importance of the m-learning implementation. It is the use of mobile technology in the educational process, the use of a wide range of digital portable mobile devices and applications. The best pedagogical experience in the implementation of mobile learning on the example of the use of QR codes is summarized. The main resources for creating and reading QR codes, examples of their use in educational activities are highlighted.

Our own experience of using QR codes in the professional training of future biologists and teachers of natural sciences has been revealed. In particular, it is used in the Museum of Nature of Zhytomyr Ivan Franko State University to expand the museum's capabilities, the application of its exposition for educational excursions, independent work of students, to organize quests and educational games and more. The stages of projects using QR codes are described: the digital guide "Dendrological Secrets of Chaudoir Park" (the mayor grant for gifted youth) and "Digital Dendrological Guide of Zhytomyr" (the project of social action "Strengthening Intersectoral Cooperation for Social Cohesion", co-financed by the European Union and the British Council in Ukraine). Their implementation contributes to the creation of information space for Biology lessons,

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open-air Ecology, classes of ecological and naturalistic circles, botanical, biogeographical, ecological excursions, development of hiking tourism, etc.

Key words: *professional training, future biologists, teachers of Natural Sciences, digital competence of educators, m-learning, QR-code.*

ВИКОРИСТАННЯ QR-КОДІВ У ПРОФЕСІЙНІЙ ПІДГОТОВЦІ СТУДЕНТІВ ПРИРОДНИЧОЇ ТА ОСВІТНЬОЇ ГАЛУЗЕЙ

Р. К. Романюк, Л. А. Константиненко, Л. А. Васільєва

У статті підкреслено значущість інформаційно-цифрової компетентності педагогів, що передбачає здатність орієнтуватися в інформаційно-цифровому просторі, здійснювати пошук і критичний аналіз інформації, використовувати освітні електронні ресурси та створювати нові, застосовувати цифрові технології в освітньому процесі. Зазначено, що європейська рамка цифрової компетентності освітян виділяє шість основних сфер застосування: професійна залученість; цифрові ресурси; викладання і навчання; оцінювання; сприяння цифровій компетентності учнів.

Розкрито важливість використання мобільної технології в навчальному процесі, застосування широкого спектру цифрових портативних мобільних пристроїв та застосунків. Узагальнено передовий педагогічний досвід щодо впровадження мобільного навчання на прикладі використання QR-кодів. Висвітлено основні ресурси для створення і зчитування QR-кодів, приклади їх використання в освітній діяльності.

Розкрито власний досвід застосування QR-кодів у професійній підготовці майбутніх біологів та вчителів природничих дисциплін. Зокрема, у музеї природи Житомирського державного університету імені Івана для розширення можливостей музею, використання його експозиції для проведення просвітницьких екскурсій, самостійної роботи здобувачів освіти, для організації квестів та навчальних ігор тощо. Описано етапи виконання проєктів з використанням QR-кодів: цифровий гід "Дендрологічні таємниці парку Шодуарів" та "Цифровий дендрологічний гід Житомира". Їх виконання сприяє створенню інформаційного простору для проведення уроків біології, екології під відкритим небом, занять еколого-натуралістичних гуртків, ботанічних, біогеографічних, екологічних екскурсій, розвитку пішохідного туризму тощо.

Ключові слова: *професійна підготовка, майбутні біологи, вчителі природничих дисциплін, цифрова компетентність освітян, m-learning, QR-код.*

Introduction of the issue. With the adoption of the Professional Standard for Teachers of General Secondary Education in 2020 [4], information and digital competence was identified as one of the most important among the professional competencies of teachers, which includes the ability to navigate in information and digital space, search and critically analyze the data obtained, use educational electronic resources and be able to create new ones, apply digital technologies in the educational process. In the European educational space, the role of the teacher is seen in partnership with students, parents, colleagues and the community. The teacher's ability to learn throughout life, his/her willingness to use ICT in the educational process and be open to innovation is highly valued [3: 64]. The growing role of information and digital competence of citizens is also due to the transition of educational institutions to distance and blended learning, which is associated with the COVID-19 pandemic. Information-communication competence and digital literacy today are a necessary condition for the existence of society in the XXI century, and therefore, an important component of training in higher education.

Current state of the issue. Analysis of scientific sources indicates the

steadily increasing intensity of scientific research aimed at solving issues of organization and use of digital educational environment, as well as at analyzing ICTs of training and management and computer-based learning tools.

The European Framework of Digital Competence for Citizens has been developed and presented by foreign scholars [14]; in 2018 the European community developed a digital competence framework for educators (*DigCompEdu, Digital Competence of Educators*), which describes in detail the competence of teachers in the field of ICT [15]. According to O. Ovcharuk, this document is aimed at teachers at all levels of education – from early childhood to higher education and adult education, covers professional education and training, including special educational needs and non-formal learning. The *DigCompEdu framework* for educators identifies their ability to use ICT to support creativity, active citizenship and social inclusion; communication and cooperation with other people; digital and information literacy; digital content creation, cybersecurity and problem solving [4]. The framework of digital competence of educators identifies the main areas of application: professional involvement; digital resources; teaching and learning; evaluation; promoting students' digital competence [15].

Domestic educators pay considerable attention to the development of digital competence of teachers. Thus, the Institute of Information Technologies and Teaching Aids of the National Academy of Pedagogical Sciences, the University of Education Management, the Institute for Modernization of Educational Content publish an electronic scientific journal "Information Technologies and Teaching Aids", as well as organize scientific seminars [12].

Important issues of theory and practice of formation of information competence of teachers and students are revealed in the works of A. Huirzhiy [1], O. Spirin, T. Vakaliuk [8], O. Ovcharuk [3], M. Striuk, S. Semerikova [9] etc.

In recent years, the concept of m-learning (mobile learning) has emerged in pedagogy. Thus, O. Liashenko, S. Tereshchuk understand this concept as the use of mobile technology in the educational process, which implies the use of a wide range of digital portable mobile devices and applications that allow systematic operations to search, process, disseminate information in educational activities [2]. M-learning is becoming more widespread and is available to many students. Such training does not require specially equipped computer classes, complex programs, and is understandable for young people. It is no coincidence that one of the trends in education in the XXI century is the exploitation of the concept of BYOD-technology (Bring Your Own Device), which is based on the use of their own gadgets in the educational process (often more powerful than existing personal computers in educational institutions) with 3G/4G connection [2; 11].

Outline of unresolved issues brought up in the article. However, despite the advantages of mobile learning, the issue of methodological elaboration of the practice of effective use of mobile devices and other gadgets (smartphones, iPhones, tablets, netbooks, etc.) in the educational process remains incomplete. Currently, there is no systemic analysis of this issue in the scientific and pedagogical literature, in particular, in the training of students of environmental sciences and future teachers of biology, basics of health, chemistry, geography, etc.

Aim of research is a generalization of authors' own experience of professional training of future biologists and teachers of environmental sciences to mobile learning on the example of the use of QR-codes.

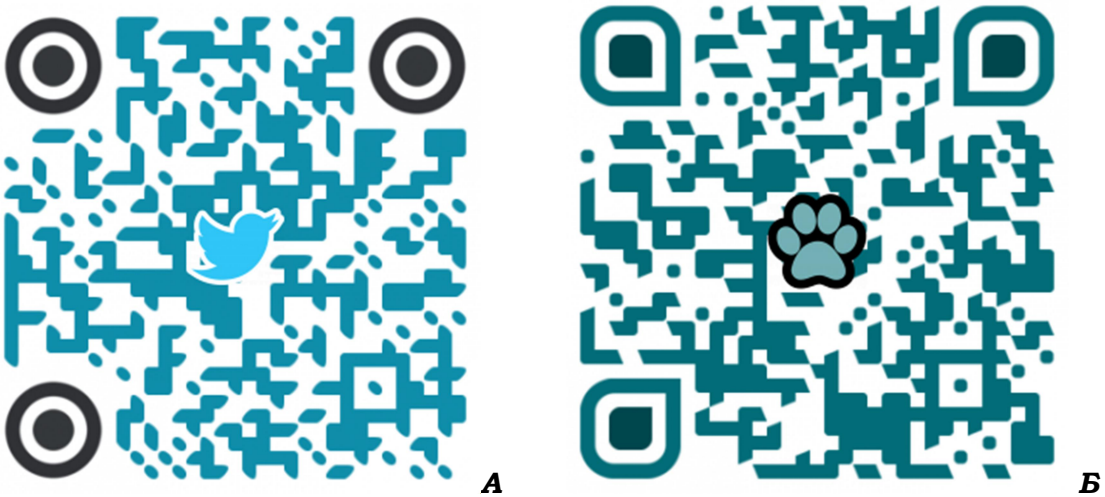
Results and discussion. The use of QR-codes has become a casual, fast, simple and convenient system of

information perception in the modern world. Quick Response Code technology is a matrix (two-dimensional) code, visually represented in the form of black and white squares that form a maze pattern. This technology originated in 1994 in Japan at Denso-Wave (a subsidiary of Toyota), had the form of a two-dimensional barcode and was used to label auto parts. Later, the barcode was transformed into the usual squares [10; 13]. This is a very capacious information technology: in one QR-code it is possible to encrypt: 7089 digits, 4296 characters (including Cyrillic), 1817 hieroglyphs! The code can contain any text combination, digits and symbols, which allows to read hyperlinks, e-mails, YouTube videos, geographical coordinates, geolocations on Google Maps, links to the profile page on social networks, audio file, etc. With the help of QR-codes it is possible to "read" a small text or number without accessing the Internet [7; 10; 13].

The advantage of this method is that everyone can not only exploit it by reading QR-codes using non-professional devices (mobile phones, tablets), but also quickly create necessary QR-based materials free of charge – individual needs only access to the Internet, a printer and a digital camera. The most used resources in Ukraine for creating QR-codes are: http://qrcodes.com.ua/; http://ua.qr-code-generator.com, https://qrcode.website/.

In this case, data on the type of code (link, text, phone, business card, card, sms, e-mail, etc.) is entered into the QR-generator window (web service), after which the QR-image is automatically generated. The generated codes are saved as a graphic image (jpg, png, tiff, pdf, etc.), which can be printed and placed anywhere. Some QR-generators contain a gallery of user-generated codes, allowing to choose color, size, error correction level, element shape, pattern, etc. (Fig. 1).

QR Droid programs (for Android operating system), Neoreader (an iOS equivalent), QRreader are used to read QR-codes. In general, most modern smartphones have a built-in code reader (the "QR and barcode scanner" application in Xiaomi, Samsung). Otherwise, the app can be downloaded from the respective store (for Android – Play Market, for iOS – AppStore) or the following site can be used https://www.the-qrcode-generator.com/scan.



А ***Б***

Fig. 1. Examples of QR-codes of exhibits of the Museum of Nature of Zhytomyr Ivan Franko State University (A – birds, B – mammals)

Due to excessive simplicity of use and overall accessibility, free QR-codes are widely used in educational activities of both foreign [16] and domestic

educators-practitioners, whose experience is summarized on educational platforms "Universal Education", "Lesson", "TEACHHUB", etc. [7; 10; 13]. It is noteworthy that the winner of the competition "Teacher of the Year 2017" Natalia Pudryi (biology teacher, principal of secondary school of I-III degrees № 12 Berdychiv city, Zhytomyr region) in her professional activity uses QR-codes when studying new topics to create mental maps, educational games; she also uses PLICKERS app for testing. [5].

Summarizing the experience of educators [5; 7; 10; 13; 16] and reflecting on their own teaching activities, we can identify the following opportunities to use QR-codes in the educational process in whole and in the process of training biology students, future specialists in the environmental sciences (chemists, ecologists, geographers, etc.), teachers of environmental sciences:

- Elements of the quest and/or educational game;
- Hidden hint to perform tasks, exercises;
- Tool for rapid dissemination of information;
- Element of homework, reporting form;
- Additional tool for working with literature;
- Handouts for a lecture or lesson with access to interesting applications (hyperlinks to videos, audio resources, sites, articles, etc.);
- Instructions for laboratory / practical work;
- Use in the system of catalogs of the library of the educational institution;
- On museum exhibits, enriching their exposition with additional educational and scientific material, video, audio support;
- Excursion route near historical and cultural monuments;
- Appendix to the means / object of training (for example, QR-codes on anatomical models, wet preparations will add information on their functioning; on geographical maps they can contain brief information on culture and history; customs and traditions); periodic table of elements – physical and chemical properties of elements, etc.);
- Use in assessment tasks to consolidate the studied material, coding tasks for individual or group work;
- Placement of contact information on the business card / office of an educator, the administration of the educational institution, on the badges of conference participants, etc.

QR-codes have great potential for creative classes, activation of cognitive activity of students, which allows to make classes more exciting and effective. On the one hand, it is convenient for pupils or students to read information and store it operatively in the memory of mobile devices, on the other hand, such an approach allows to use additional resources.

Thus, in the Museum of Nature of Zhytomyr Ivan Franko State University QR-codes that contain an internet link to the Ukrainian-language encyclopedia of animals were places near some exhibits allowing the visitors to obtain detailed information about habitat, morphological, physiological, ecological, behavioral features of a particular animal species (Fig. 1). This initiative significantly expands the possibilities of the museum, including the use of its exposition for educational excursions for different groups, independent work of students in the study of educational components (zoology, biogeography, ecology, bioresources, etc.), as a territory for quests and educational games, etc. Examples of successful projects we have implemented using QR-codes that contained links to the digital guides "Dendrological Secrets of Shoduar Park" (Mayor's grant for gifted youth) and "Digital Dendrological Guide of Zhytomyr" (grant under the social action project "Strengthening intersectoral cooperation for social cooperation for cohesion", co-financed by the European Union and the British Council in Ukraine) [6].

Carrying out excursions to nature for students and pupils as well as organizing training practices identified an important issue of distinguishing the species of trees. Therefore, the idea arose to create a digital dendrological guide of the city park area by installing information boards with QR-codes near unique woody plants (ornamental, medicinal, rare, with an interesting history and practical significance, etc.).

The work was carried out in accordance with the methodological principles of project-based learning and included the following stages:

1) the preparatory stage at which the working group of students and educators was selected;

2) planning activities: problem analysis, selection of objects (woody plants), identification of sources of information, distribution of responsibilities and tasks within the group;

3) research of the topic: collection of necessary information, its analysis, creation of information cases containing photographs, Ukrainian and Latin names of the plant, description of its distribution, features of biology and ecology, practical significance, interesting material;

4) execution: realization of the planned, development of design of plates with QR-codes, production of designs, their installation in park (Fig. 2).

5) presentation of the project: coverage on social networks, publication of a manual for teachers and club leaders, educational activities.

Implementation of the project contributes to the creation of information space for biology lessons, open-air ecology, classes of ecological and environmental circles, botanical, biogeographical, ecological excursions, tourism development, etc.

Fig. 2. Project information board "Digital dendrological guide of Zhytomyr"

Conclusions and research perspectives. Thus, the digital competence of the modern educator implies confident, critical and responsible use of ICT; interaction with digital technologies for educational and professional activities as well as in the social sphere. M-learning (mobile

learning) is a promising area in the process of training of environmental sciences specialists the and the future teachers. The use of own gadgets by students, as well as exploitation of a wide range of digital portable mobile devices and applications allows to systematically carry out productive information search, its further processing and dissemination during educational activities. The use of QR-codes is perspective tool and means of improving conventional educational practices. Other fields of application of ICTs and QR-based technologies in the process of professional training of specialists of environmental specialties form perspective for out further research.

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