Vol. 2. No. 2. 2023 Scientia et societus
Received: 29.07.2023.
Revised: 31.10.2023.
Accepted: 12.12.2023.
Journal homepage: https://ses.journal.in.ua/index.php/ses/issue/view/4
UDC 378.4
DOI: 10.69587/ss/2.2023.22

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Current trends in radiation safety education in the digital educational environment: Challenges and opportunities

Abstract. The population's level of radiation literacy needs to be increased due to the significant rise in the use of radiation technologies in medicine, industry, science, and other fields. Simultaneously, the rapid development of digital technologies and increased access to the internet for a significant portion of the world's population have created new opportunities for radiation safety training and awareness-raising. The purpose of the study was to examine current areas and methods of teaching radiation safety in the era of digital education, to identify important challenges faced by educational institutions and students, and to identify opportunities for using modern technologies.The research employed theoretical analysis of information sources, systematization, deduction, modeling, and generalization. The article analyses the potential of modern digital learning tools in studying radiation safety. It substantiates the structural and logical scheme of using educational web resources for this purpose. The article also proposes tools for diagnosing the level of subject competence and approaches to ensuring reflection and self-reflection of the subjects of the educational process. The identified components of radiation safety training include accessibility of educational information, quality interaction of participants, objective evaluation of results, and reflection and process analysis, specialized web services have also been identified to aid in their implementation in a digital educational environment. The study's results will be valuable for training non-specialists who may encounter radiation risks from domestic, man-made, natural, or military sources, they will also be useful for specialists studying ways to improve radiation literacy among different segments of the population

Keywords: radiation literacy; ionising radiation; augmented reality; virtual reality; competence diagnostics; digital learning tools

INTRODUCTION

The modern world requires continuous transformation and development of the radiation safety (RS) education system due to the growing use of radiation technologies in medicine, industry, science, and other areas. At the same time, the rapid development of digital technologies and increased access to the Internet for a significant number of the world's population create new opportunities for learning and raising awareness of RS. In these circumstances, it is recommended to assess how current trends in radiation biology education impact the educational environment, the challenges they present to educational institutions, and the opportunities they offer in the context of utilising the latest digital technologies. Understandably, interest in radiation education is significantly increasing in countries that have experienced the consequences of radiation disasters.

In particular, researchers T. Sawano *et al*. (2018) emphasise the importance of radiation education for all segments of the Japanese population. They suggest that continuous and sustained radiation education is necessary to increase the overall level of knowledge after the Fukushima nuclear power plant disaster. Studies have shown that there are significant gaps in the general population's knowledge of radiation, which are due to imperfect approaches to teaching radiation safety basics (Sadigh *et al*., 2014). The expansion of radiation technologies in industries, agriculture, and research has led to a need to improve radiation

Suggested Citation:
Tymoshchuk, O. (2023). Current trends in radiation safety education in the digital educational environment: Challenges and opportunities. *Scientia et societus*, 2(2), 22-30. doi: 10.69587/ss/2.2023.22.

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literacy among the younger generation in some countries. For instance, innovative demonstration tools are used to teach radiation literacy to secondary school students in Sri Lanka at the national level (Ranasinghe *et al.*, 2019). Training to improve radiation literacy among the younger generation is conducted with the assistance of the International Atomic Energy Agency (IAEA) and the University of Tokyo to meet national requirements. According to some researchers, game-based learning methods have been highly effective in teaching primary school students about radiation and its associated risks (Yamaguchi & Horiguchi, 2021). Studies have shown that radiation awareness is essential for kindergarten teachers in areas with potential radiation risk or those affected by radionuclide releases (Moriyama *et al.*, 2022). Additionally, companies that use nuclear technologies are actively involved in public radiation education. An example of this approach is energy tourism, which involves observing the operation of nuclear facilities to form ideas about safety and security (Gerulaitienė & Mažeikienė, 2021). It is important to note that radiation safety training is actively implemented at national and international levels. The Asia-Pacific region has a pilot project for intergovernmental cooperation at the secondary school level. The project aims to involve experts in developing educational tools to promote radiation literacy among schoolchildren (Iimoto *et al.*, 2019). It has been established that the introduction of radiation technologies requires the improvement of general radiation and special training in this area. This, in turn, will reduce public concern about man-made and terrorist accidents at nuclear facilities (Cho *et al.*, 2019). Considering the issues outlined in the presented studies, it is imperative to improve radiation literacy among people of all ages, regardless of their location or professional activities. Therefore, this study aimed to investigate current trends and methods of teaching radiation education in the digital era. The task was to identify the significant challenges faced by educational institutions and students and opportunities for using modern technologies.

MATERIALS AND METHODS

The study is based on a theoretical and review approach and does not contain empirical results of an experimental nature. In the course of the study (initial stage), the method of analyzing modern practices of teaching radiation safety in the digital educational environment was used. Based on the results of the analysis, they were differentiated depending on their characteristic features, and the following groups of educational practices for radiation safety education were identified "use of virtual and augmented reality tools", "use of multimedia visualization tools" and "interactive interaction of participants in the education process". The approaches to teaching radiation literacy identified in the study were compared with the current needs of the educational process. At the same time, the research was based on the study of the didactic potential of digital learning tools through their critical analysis. In particular, the possibilities of remote access to educational materials such as Google Drive and Dropbox were investigated. The criteria used to analyze them included ergonomics of use, collaboration tools, opportunities for differentiated learning, integration with other learning resources, security, and privacy. The study also analyzed the diagnostic tools of the web services Google Forms, Kahoot, Quizizz, namely the possibilities of assessing students' learning achievements and reflection. These services were evaluated according to the following criteria: the ability to create different types of tasks, integration with other educational resources, and the ability to analyze the results. The Google Analytics web service was studied as an analytical tool for the effectiveness of radiation safety training in a digital educational environment. In particular, its capabilities in terms of collecting data on visitors, their geolocation, the pages they view, and the duration of their visits to web resources were evaluated. The possibilities of "Google Meet" and "Zoom" in the context of ensuring social, digital, and interactive interaction of participants in the educational process are investigated, in particular, the possibilities of video conferencing, file sharing, recording classes, questionnaires, and surveys are analyzed.

The optimal tools for achieving the goals of radiation safety training were selected by modelling training cases and analyzing the didactic potential of existing tools. The most effective tools for teaching radiation safety in a digital educational environment are identified using scientific methods of comparison and contrast. These tools are differentiated based on their accessibility to educational information, quality of participant interaction, objective evaluation of results, reflection and self-reflection, and analytical tools. The study's findings are presented through hierarchical and cyclic diagrams. The materials used for this study included scientific publications, regulatory documents, statistical data, and technical specifications of digital learning tools, as provided by the manufacturers' websites. The study utilized academic search engines such as "Google Scholar" and "Microsoft Academic Search", as well as electronic journal databases like "Open Journal System" and "Scimago Journal & County Rank". Additionally, it drew upon materials from international projects, including the "EURAMED Rocc-n-Roll project survey (Education and training in radiation protection in Europe, 2023)" and "Synergy for Nuclear/Radiation Asian Teacher/Student Development (2019)". The presented materials are not subject to any restrictions on information disclosure or data access.

Results

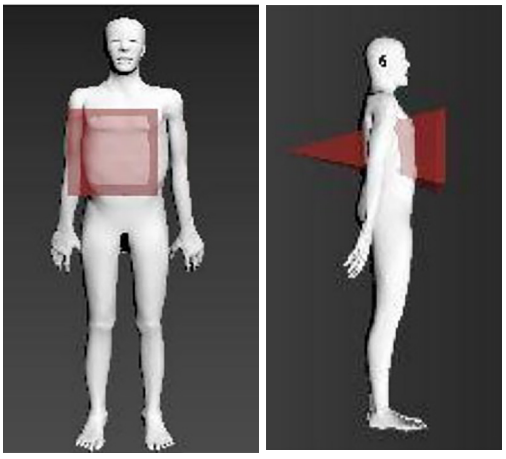
One important area of pedagogical research and educational policy is the process of digitalization in education. The goal of education is to ensure that all participants in the educational process have mastery of digital skills and competencies, which is an important factor in the comprehensive and successful development of society and the economy of the state as a whole. Learning in a digital educational environment is a new area of pedagogical research (Schüler, 2019). The digital transformation of the

educational environment requires the appropriate retraining of both teachers and higher education students. Israeli scholars have identified two strategies for digitalizing the educational environment: conservative and skeptical. According to the conservative view, the digitalization of the educational process involves adapting educational organizational and technical approaches to modern computer science technologies, while the skeptical view, on the other hand, requires a complete transformation of the pedagogical process, including a fundamental rethinking of the interaction between participants in the educational process, this is referred to as the postmodern interaction between teachers and students (Aviram & Eshet-Alkalai, 2006).

Learning in the digital learning environment is considered in terms of the following strategies: social and virtual, Internet-based resources, interpersonal communication on the network, and digital tools (Ferdian & Chayanuvat, 2017). The digital learning environment contributes to more effective cognitive engagement of students, resource management, and the formation of motivational beliefs (Anthonysamy *et al.*, 2021). However, the digitalization of the educational environment has both advantages and disadvantages. While there are positive examples, studies have also identified a decrease in the motivation of higher education students in online teaching and learning. It is important to note that in digital learning environments, students' intrinsic motivation is the primary driving force, and the teacher's motivating influence is somewhat reduced, that can have an impact on the level of learning and cognitive activity (Hartnett, 2016). Teaching in a digital learning environment requires both comprehensive pedagogical and technical training. According to J. Macleod *et al*. (2018), higher education students place the greatest value on learning environment tools that facilitate negotiation, experiential learning, reflection, ease of use, and usefulness. The quality and ease of communication, as well as the design of applications, are noted to play a crucial role in student engagement.

The teaching of radiation safety in the digital educational environment is often studied as a scientific problem with a focus on training specialists who work directly with radiation sources. However, studies on the formation of radiation literacy using digital means are fragmented and do not adequately address the current challenges and opportunities of the digital educational environment. For instance, A. Tekbiyik (2015) outlines the means of interaction, reflection, and collaborative learning in forming objective views of bachelors (future science teachers) on the use of nuclear energy. The author argues that distance learning, exclusively used in this case, allowed for a wider audience and collective learning through information and communication technologies (ICT). The educational presentation aims to enhance comprehension of the physical basis of ionizing radiation and its effects on the human body. The use of digital learning tools facilitates a high level of understanding of alpha, beta, and gamma radiation, which in turn promotes competence in radiation protection basics (Ribeiro *et al.*, 2020). Digital technologies significantly enhance communication between participants in the educational process, provide high-quality visual representations of information, and expand the possibilities for visualizing certain processes in static and dynamic conditions. Ukrainian researchers have developed immersive technologies for training personnel working with nuclear technologies, based on augmented and virtual reality (Popov *et al.*, 2021). Modeling the operation of hazardous equipment is a key aspect of using these digital tools, resulting in a higher level of safety and improved basic training of personnel. Thus, digital technologies not only serve a didactic purpose but also contribute to health protection and the development of competencies for safe human activity in the face of radiation risks.

The Department of Engineering and Applied Physics at the Chinese University of Science and Technology (Hefei) conducted a study on the integration of virtual reality (VR) technologies with dosimetric equipment, the researchers developed a virtual reality application for this purpose. The virtual visibility headset is used in conjunction with radiological equipment. The student can 'see' the spatial distribution of the X-ray field and the dose rate is displayed on the screen in real time (Guo *et al.*, 2020). This allows them to adjust their actions and minimize the harmful effects of radiation on the body while developing safe behavioral skills. The approach described should be used to understand the geometric parameters of radiation propagation. For instance, an augmented reality tool that illustrates the areas of exposure of the human body could be effective in comprehending the geometric outlines of X-rays during radiological chest diagnosis (Fig. 1). This tool helps students to understand the geometry of radiation visually. The provided conditions explain how the placement of the ionizing radiation source and the detector affects the geometric parameters of radiation. It is important to include information on safe behavior during such procedures, minimizing radiation dose absorption, and personal hygiene measures.



A B

Figure 1. X-ray image of a human being
Notes: A - top view; B - bottom view
Source: Y. Guo *et al*. (2020)

In terms of using augmented reality tools, it is recommended to employ methods for detecting or marking target objects or locations during RS training. As suggested by F. Biocca *et al*. (2007), this approach can be useful for identifying potentially hazardous objects by marking them with a frame. In the study of RS, augmented reality tools can be used to train personnel working with radioactive materials by creating simulation situations and virtual training programs. According to the results of surveys presented within the framework of the Euramed project, the main task of the pedagogical community, whose specialists teach the disciplines of the cycle of emergency response, is to adapt curricula and teaching methods to the practical side of protection against radiation threats (Santos *et al*., 2023). In this context, the project method deserves significant attention. As part of project preparation, students demonstrate their competence in safety basics through a personality-oriented approach to assessing learning achievements. The implementation of projects is made possible by numerous web applications that improve the structure of the material, graphic content, and interactive effects.

A number of studies focus on the active interaction of participants in the e-learning process dedicated to the formation of radiation literacy. It is recommended to organize electronic or distance learning sessions that focus on interactive participation, allowing participants to acquire new knowledge independently (Zafar *et al*., 2014). Some researchers argue that online learning has no positive impact on radiation safety. For instance, a study suggests that professionals working with medical radiation technologies have low rates of competence improvement in radiation risk prevention. Practitioners who use radiation diagnostic tools did not significantly increase their level of competence after completing specialized online courses, as evidenced by the results of the Kirkpatrick assessment (Kowalczyk, 2014). Based on the experience described above, it is evident that investigating the mechanisms of interaction among participants in the educational environment during digital transformation is a pertinent and pressing matter. However, it necessitates the exploration of effective methods for teaching RS. Certain studies have focused on personalized learning trajectories, where the student can manage the process of knowledge acquisition and track personal progress. Such an approach with the use of digital technologies is interpreted as "self-regulated learning" (Johnson & Davies, 2014; Xia *et al*., 2023). Organizing learning in this way requires planning and managing time, effort, and resources. Learners who develop plans and strategies to achieve personal goals are actively engaged in learning. Web-based technologies are particularly suitable for facilitating active engagement of learners in the learning process (Sahni, 2023; Huang & Wang, 2023). Therefore, to improve the effectiveness of radiation safety and radiation literacy education in the digital environment, it is recommended to analyze the potential of existing web-based tools.

Dropbox is a cross-platform file sharing service that enables users to upload files to a server. One of its key features is the accessibility of resources from any device, including computers, tablets, and smartphones, regardless of the operating system. Additionally, the user interface allows for file creation and editing, making it possible to prepare training reports remotely (Dropbox Help Centre, 2023). Google Drive (2023) is a multitasking service provided by the digital Internet giant that offers a wide range of tools for accessing learning materials. In addition to storing and synchronizing files on the server, Google Drive enables users to create and collaboratively edit various file types. The service also allows for the storage of photos, drawings, audio recordings, and videos, with each user being provided with 15 GB of disk space. The tools included in Google Drive are: Google Drive offers a suite of tools including Docs, Sheets, and Presentations. It also provides powerful access management features, allowing for personalized access with the ability to copy, edit, and distribute files. This helps to ensure organized access to educational materials and protects against copyright infringement of teaching materials (Google Drive Help, 2023).

The importance of objectively assessing students' learning achievements in the digital learning environment cannot be overstated. This is highlighted in a study on digital knowledge assessment by B. Thoma *et al*. (2019), which identified the use of machine (test) control in combination with communication as an approach. It is important to note that the most objective results of diagnosing learning achievements can be guaranteed if the individual professional and social attitudes of students are taken into account (Kümmel, 2020). Diagnosing the level of knowledge of radiation risks is challenging due to the complexity of the cognitive dimension, as well as the motivational and axiological assessment. Ultimately, modern web-based knowledge assessment tools should be utilized to diagnose the level of knowledge regarding radiation safety. Quizizz is a service that enables the creation and publication of tests of varying complexity on a user's profile, with access granted to specific users. Additionally, audio, video, and graphic files can be attached to questions to enhance comprehension of the topic. The teacher can monitor the completion, comprehensiveness, and timeliness of test tasks. Kahoot is a platform specifically designed for conducting surveys and tests, suitable for various age groups. It also enables the integration of graphics and videos (Quizizz Help Centre, 2023). The Test and Lesson Designer was developed with the support of the Ministry of Education and Science of Ukraine. It enables users to create an unlimited number of tests and store them on the free platform of the same name. The service provides detailed statistics on diagnosing the level of knowledge and skills, allows for test time planning, and stores the results (Test builder "Vseosvita", 2023).

Another approach to optimize the process of learning about radiation is through the use of interactive animations. Animations can aid in understanding complex numerical indicators of radioactive radiation, particularly for individuals with low radiation literacy (Housten, 2020). For instance, animations can be utilized when studying

radiation sources such as the sun, nuclear reactors, household radiation sources, medical radiological equipment, radioactive waste, and natural materials. To ensure comprehensibility and logical structure, it is recommended to present the animation linearly, beginning with natural radiation objects and concluding with household and man-made ones. This approach also facilitates the learning process of radiometric equipment operation by analyzing its structure and use step by step (Bakri, 2019). To comprehend the intricate processes of ionizing radiation propagation in space, we developed a 3D animation module that simulates the propagation of radioactive gas in residential premises (García-Tobar, 2020). The integration of animation visualization tools into the study of various types of electromagnetic radiation has yielded significant results (Ambarwati *et al.*, 2019). The utilization of animation is particularly effective for self-study and developing critical thinking skills in students (Fig. 2).

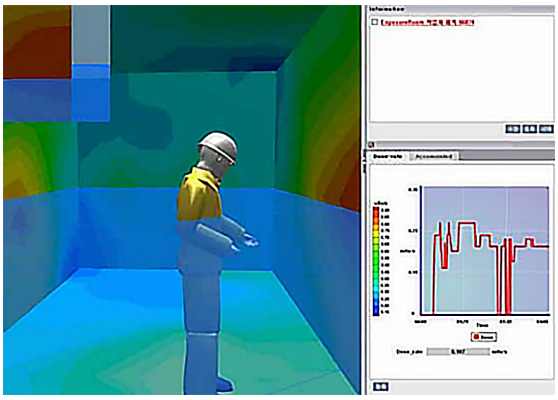


Figure 2. Animation of modeling employee exposure depending on the activity of the ionizing radiation source
Source: D. Ambarwati *et al*. (2019).

Significant attention in the study of each discipline, including RS, should be paid to the issue of "learning from mistakes" or reflection. The main purpose of reflection is the ability of this tool to improve the teaching practice of a particular discipline (Veine *et al.*, 2020). Reflection and self-reflection is a tools designed to identify gaps between the teacher's theoretical position on the organization of learning and the practical side of direct implementation (Morley, 2011). At the same time, critical reflection is a key means of self-correction of activities, in the context of distance education, of teachers and students in particular (Evans & Nation, 2020). Digital tools of the modern information environment allow to ensure an appropriate level of reflection and self-reflection due to the sufficiently flexible privacy settings, which allow teachers and students to draw objective conclusions. One formality for encouraging reflection is an open online discussion among educational stakeholders (teachers, students, etc.) about diverse aspects of the learning experience. For this purpose, it is advisable to use well-known services for organizing online video conferences, such as Google Meet, Zoom, Microsoft Teams, or their analogs. For informal reflection, such tools are not very effective, as most students are hesitant to speak out about problematic issues in the study of a particular discipline. To solve this problem, it is advisable to use applications that allow for the anonymity of expressing opinions, in particular, such services include testing tools, social networks, etc. The use of digital tools will allow for the prediction of negative and critical scenarios in the educational process, and thus improve the quality of teaching, and as a result, increase the level of competence in the basics of RS.

In the global space, where the analysis of all types of activities is essential, the educational process is no exception. All data can be analyzed and visualized in the form of summary tables and diagrams, allowing for the tracking of correlations between teacher and student performance (Lepouras *et al.*, 2014). The digital learning environment has a wide range of analytical tools that enable the tracking of visitor geolocation, activity, and task completion time. Such tools, like Google Analytics, enable the evaluation of a particular web page based on various criteria, such as the number of visitors, page popularity, duration of stay, and traffic sources. The purpose of analytical educational tools is to select statistical data, process it, and prepare reports that inform management decisions (Sclater *et al.*, 2017). For instance, by using Google Analytics, a teacher can track the time spent on a resource, the specific section accessed, and the duration of use. This information alone enables the teacher to evaluate the effectiveness of learning tools, the level of student motivation, and the usability and comprehensibility of learning materials. The digital learning tools described demonstrate highly effective indicators in the study of RS. At the same time, the analyzed experience is fragmentary and provides certain aspects of the educational process. It is advisable to define a holistic structure for the use of digital learning tools in RS in this discourse.

Considering the significant volume of analyzed works, it can be stated that digitalization of RS learning should be ensured, taking into account the following criteria: accessibility of educational information, quality interaction of participants in the educational process, objective assessment of learning outcomes, reflection and self-reflection, and analytical tools for assessing the learning process. The implementation of these criteria presents several pressing challenges related to the technical, organizational, and pedagogical aspects of the educational process. It is important to note that Dropbox and Google Drive allow multiple users to collaborate, facilitating the quick creation of documents and project management through work schedules, task lists, and spreadsheets. This supports A. Tekbiyik's (2015) view on the effectiveness of collaborative learning. An integrated calendar enables the implementation of a schedule for completing learning tasks by providing intelligent reminders and recording completed iterations. In addition to the web services described above, many others allow the use of cloud storage and collaboration tools. However, Dropbox and Google Drive are the most popular in the educational sector. The author presents the structuraland functional model for using these services in the form of a diagram (Fig. 3).

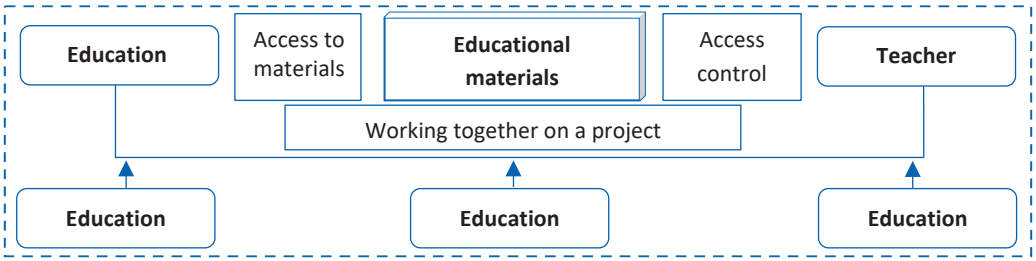


Figure 3. Flowchart of using web services to access educational materials

Source: developed by the authors

To ensure the availability of educational information, virtual and augmented reality, as well as cloud storage services, should be utilized. Additionally, integrating infographics and animation can optimize the process of learning about the RS. Such an approach to presenting information can enhance the process of visualizing complex information. Traditional textbooks and visual aids often lack easy-to-understand graphic materials. It is important to evaluate the effectiveness of digital learning tools in the study of RS. The learning outcomes of the RS can be objectively assessed through various tools in the digital educational environment. It is necessary to use automated assessment systems that enable teachers to create different types of tests, analyze results, and assess student learning achievements objectively and without bias. To evaluate the effectiveness of learning in a digital environment, it is recommended to use Google Forms. This service provides tools to track the general trends of a specific audience through open and anonymous surveys. Additionally, it allows for the collection of summary statistics on specific issues, enabling the identification of general trends. Further discussion is required to determine how to integrate these tools and approaches into the learning process of the Security Council. To illustrate the ways to optimize radiation safety education, the author has provided a hierarchical schematic diagram (Fig. 4).

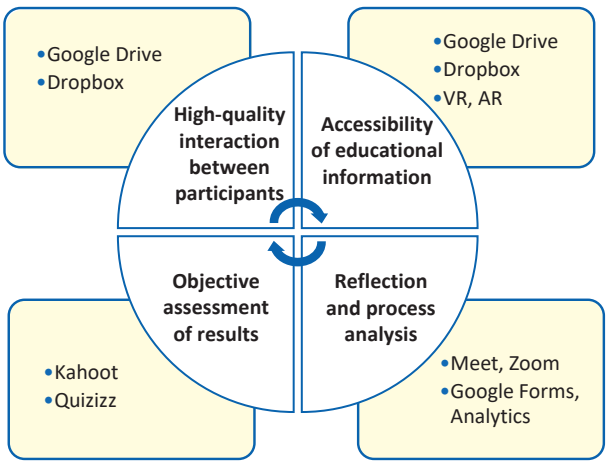


Figure 4. Modern digital tools for teaching radiation safety in a digital educational environment

Source: developed by the authors

The diagram shows potential methods for effectively organizing RS education in a digital learning environment. It is important to avoid using similar tools that lack the necessary features to achieve the desired educational outcome. Effective interaction among participants in the educational process is possible through the qualitative mastery of the described tools and reliable technical support. The development of innovative learning tools deserves considerable attention (infographics, animation, augmented and virtual reality), justification, and verification of the effectiveness of their use in the study of Security Studies. However, it is crucial to maintain objectivity when evaluating their effectiveness. To implement these tools in a digital educational environment, a coordinated and integrated approach is necessary. Educational web resources can serve as a central hub for the use of these tools. The main challenge in using the methods mentioned above to support education is obtaining financial resources for teaching aids, providing specialized training for teachers, and improving teaching methodologies. The RS training system, described here, allows for training to be conducted in vocational and higher education institutions, retraining centers, and training centers of specific enterprises or institutions. Adapting to the requirements of various educational institutions is accomplished through a customized approach to course material, which considers the students' previous knowledge. This guarantees consistency and enables the adjustment of teaching techniques to cater to different age groups.

CONCLUSIONS

Analytical review of modern trends in radiation safety education in a digital educational environment allows to declare a number of intermediate results, namely: research on the integration processes of modern digital technologies for radiation safety study has been widely conducted by researchers from different countries; The majority of recent research focuses on software tools for web technologies and augmented or virtual reality in learning; Modern directions of radiation safety education in a digital educational environment have been identified, such as: accessibility of educational information, quality of interaction between participants, objective assessment of results, reflection and self-reflection, analytical tools in the assessment of the educational process; Based on the tools of analyzed digital learning tools, a structural-logical scheme

of interaction between subjects of the educational process and access to educational information has been developed; Systematization and synthesis of research, as well as digital technologies, allow to develop a process diagram for the use of digital radiation safety learning tools in a digital educational environment.

At the same time, the examples, peculiarities of the methodology of using digital tools in the study of RS, as well as the challenges related to their integration into the educational process, in particular, the insufficient development of digital learning tools, the low level of training of educational subjects in interaction in the digital educational environment, increase the efficiency of RS teaching methods. The article presents effective theoretical foundations for the coordinated use of modern digital teaching aids for RS. By studying the research vectors of the academic community and state and international projects, several trends related to radiation safety education in the digital educational environment can be identified, namely: integration of digital learning tools into all stages of the educational process, adaptation of education to individual needs and characteristics of students, ensuring joint work on projects. These trends create new opportunities to improve the effectiveness of radiation safety education, but they also pose certain challenges for educators. One of these challenges is to ensure the quality of digital learning, ensure student safety prevent information violence, and adapt existing or develop new digital learning tools. Undoubtedly, the outlined study represents the theoretical side of current trends in RS education in the digital educational environment, and it is relevant and appropriate to conduct an empirical study of the effectiveness of the system of the proposed tools, which will be carried out in future scientific developments.

ACKNOWLEDGEMENTS

The author expresses sincere gratitude to the specialists of the Department of General Technical Disciplines, Technologies and Civil Security of Rivne State University of the Humanities for their professional advice on the choice of the methodological apparatus of the study.

CONFLICT OF INTEREST

None.

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Сучасні тенденції навчання радіаційної безпеки в умовах цифрового освітнього середовища: виклики та можливості

Анотація. Необхідність підвищення рівня радіаційної грамотності населення зумовлена значним збільшенням використання радіаційних технологій у медицині, промисловості, науці та інших сферах. Водночас, швидкий розвиток цифрових технологій і збільшення доступу до Інтернету значної кількості населення земної кулі, створили нові можливості для навчання та підвищення рівня обізнаності щодо радіаційної безпеки. Мета дослідження полягала у вивченні актуальних напрямків і методів навчання радіаційної безпеки в епоху цифрової освіти, виокремленні важливих викликів, з якими стикаються освітні інституції та здобувачі освіти, а також виявленні можливостей використання сучасних технологій. Дослідження виконувалося послуговуючись методами теоретичного аналізу інформаційних джерел, систематизування, дедукції, моделювання та узагальнення. Проаналізовано сучасні цифрові засоби навчання та їх потенціал при вивченні аспектів радіаційної безпеки. Обґрунтовано структурно-логічну схему використання освітніх веб-ресурсів для вивчення радіаційної безпеки та запропоновано інструменти діагностування рівня сформованості предметної компетентності, а також підходи забезпечення рефлексії та саморефлексії суб’єктів освітнього процесу. Визначено перелік основних складових забезпечення навчання радіаційної безпеки (доступність навчальної інформації, якісна взаємодія учасників, об’єктивна оцінка результатів, рефлексія та аналітика процесу), а також спеціалізовані веб-сервіси, що сприятимуть забезпеченню їхньої реалізації в умовах цифрового освітнього середовища. Представлені у дослідженні результати будуть корисними при підготовці не профільних фахівців, котрі потенційно можуть стикнутися з радіаційними ризиками побутового, техногенного, природнього чи воєнного характеру, а також фахівцям котрі досліджують аспекти підвищення радіаційної грамотності різних верств населення

Ключові слова: радіаційна грамотність; іонізуюче випромінювання; засоби доповненої реальності; засоби віртуальної реальності; діагностування сформованості компетентності; цифрові засоби навчання