Anna Smelkowska

Poznan University of Medical Sciences, Department of Neurological Nursing
https://orcid.org/0000-0003-0319-4130

Agnieszka Karbownik

Poznan University of Medical Sciences, Department of Clinical Pharmacy and Biopharmacy
https://orcid.org/0000-0002-3724-0548

Barbara Purandare

Poznan University of Medical Sciences, Department of Occupational Therapy
https://orcid.org/0000-0003-4518-5881

Katarzyna Zaorska

Poznan University of Medical Sciences, Department of Histology and Embryology
https://orcid.org/0000-0002-3894-781X

Marta Jokiel

Poznan University of Medical Sciences, Department of Traumatology, Orthopedics and Hand Surgery, Physiotherapy Department
https://orcid.org/0000-0002-6078-4498

Maurycy Jankowski

Poznan University of Medical Sciences, Department of Computer Science and Statistics
https://orcid.org/0000-0001-9476-0235

Magdalena Roszak

Poznan University of Medical Sciences, Department of Computer Science and Statistics
https://orcid.org/0000-0001-6495-6771

Successful Examples of Asynchronous Teaching in Polish Interactive Remote Medical Education

Abstract

A thorough theoretical and practical preparation is crucial in the education of medical professionals. Present-day knowledge recipients expect a broad range of multimedia and interactive resources in the consumed media. The article

discusses examples of such implementations for the nationwide education of a pharmacy technician, massage technician, medical sterilization technician, and occupational therapy technician. These examples were created for the Integrated Education Platform of the Ministry of Education and Science in Poland, as part of an EU-funded project. This study delineates the characteristics of e-materials, such as instructional and educational videos, film sequences, scenario-based learning games, interactive documentation, 3D animations, simulators and virtual tours. We prepared a learner benefit analysis based on the e-materials discussed. We aimed to formulate recommendations and guidelines for designing and developing multimedia and interactive resources, paying special attention to educational values and content for the medical industry. Regardless of the type of multimedia, profession and content, materials should prioritize realism, interactivity and detailed presentation of the situations/cases. The same multimedia rarely achieve different learning objectives and learning outcomes. To design and produce high-quality multimedia, it is necessary to know their characteristics and to work with a team of subject matter experts experienced in e-learning development.

1. Introduction

The demands of medical education require a thorough academic and practical education of future medical professionals. Current developments and technological advances offer great opportunities for preparing teaching materials for remote education, including various types of multimedia and interactive resources expected by the modern consumer of knowledge (Roy, 2017; Roszak et al., 2020; Roszak et al., 2023). The achievement of the necessary learning outcomes in the education of medical personnel, sometimes difficult within traditional education, becomes possible by implementing an asynchronous e-learning component (Olivier et al., 2020; Roszak et al., 2021). Implementing innovative education in such a way seems to be the most optimal and effective method for reaching learning outcomes, as indicated by scientific reports across various fields (Kirkova-Bogdanova et al., 2018; Tabakova, 2020; Nagata, Chino et al., 2022; Silva et al., 2022; Hwang et al., 2023). This provides the opportunity, among other things, for students to repeatedly engage with e-resources, making mistakes based on individual needs. This deliberate didactic procedure, cannot take place in real-world conditions dur-

ing classes, e.g. in hospitals or pharmacies (Grześkowiak et al., 2020; Szczeszek et al., 2023).

Integrated Educational Platform

The authors point out that when designing and creating e-learning based on interactive and multimedia materials, special attention should be paid to 1) ensuring educational values through an appropriate methodology for creating such e-resources (types of multimedia and interactive resources tailored for different teaching purposes), 2) preparing authorized curricular content, and 3) implementing the technical aspect of multimedia (Roszak, 2019; Kanikowska et al., 2023). The article presents selected results of the work related to the Integrated Educational Platform of the Ministry of Education and Science in Poland. The focus is on post-secondary education in the professions of medical caregiver, pharmaceutical technician, massage therapist technician, medical sterilization technician, occupational therapy technician, orthopedic technician, and elements for the profession of medical electronics and information technology. The presented materials are the result of 2 years of work under a nationwide EU-funded e-materials project.

Multimedia and interactive resources produced

The project resulted in the creation of diverse resources, including but not limited to photo galleries, interactive boards, infographics, mind maps, e-books and audiobooks, educational videos, instructional videos, film sequences, educational games, interactive scenario-based learning type tools, exercise programs, 3D animations, multimedia and interactive atlases, simulators, virtual tours, virtual laboratories, and virtual reality tools (Smelkowska et al., 2023). This innovative government initiative promotes good quality interactive e-education, which can also inspire the preparation of a educational standards based on interactive and multimedia resources in academic teaching.

Promotion of good quality curricular content

The results of this project will be available on a nationwide scale for future post-secondary education graduates and teachers from 2023. The e-resources can also be used by other parties interested in the medical field, such as medical professionals and students. The benefits of implementing such a project include the promotion of good quality interactive e-education with access to authorized

teaching contents. All prepared resources underwent mandatory external content reviews before their final publication on the platform.

Implementation team

Multimedia and interactive e-material content preparation for medical education requires the work of an interdisciplinary team of experts. Such a team should include: content writers, content consultants (industry experts or specialists in the profession, vocational education teachers), methodologists, vocational education methodological advisors, editors, and, particularly WCAG specialists. WCAG, or Web Content Accessibility Guidelines, comprise a set of standards developed by the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C) to ensure that the web content is accessible to people with a wide range of disabilities. Knowledge providers educated at medical universities with experience in teamwork and with expertise in interdisciplinary activities are the most desirable content authors for medical e-learning. Naturally, they must have experience in the field of e-education both in the role of knowledge recipient and knowledge provider (Roszak et al., 2021).

The content resources created for the educational platform, referred to as e-resources, were categorized according to subject matter. Their main elements included selected multimedia and interactive e-materials, along with a teaching framework for the entire e-resource. The teaching framework includes: interactive review materials, a vocabulary glossary, teaching guides for both teachers and students, bibliography and netography, and instructions for using the e-resource. Everything adhered to content and teaching standards, prepared to support selected learning objectives in line with the profession's core curriculum.

The Ministry of Education and Science, as part of the project guidelines, pre-established the quantity, the subject diversity of e-resources, and the variety of multimedia employed within a specific profession, as well as the professions for which e-materials were created according to predefined standards. The article discusses examples of implementation of the integrated educational platform for the professions of medical sterilization technician, massage therapy technician, occupational therapy technician and pharmacy technician. The article presents specific types of multimedia which, according to the authors, pose challenges in terms of content or technical development. In addition, their implementation is associated with a high financial cost. Due to the extent of the issue, the authors plan to present examples for the other health professions within the project (medical career, orthopedic technician, electronics and medical informatics technician) in subsequent publications.

2. Characteristics of the analyzed multimedia and interactive resources

This chapter highlights key features of specific multimedia and interactive materials, with practical examples showcased in point 3.

Videos, both educational and instructional, as well as shorter formats like film sequences covering several topics, are an important and interesting element of remote education. According to the research available, students themselves admit that the use of videos in education improves the quality of education and increases their involvement in the learning process (McAlister, 2014).

Video sequences

These sequences allow for the presentation of individual processes and the implementation of specific professional tasks. Graphics and diagrams are placed throughout the sequence to facilitate comprehension, with each video sequence lasting approximately 5 minutes. The material also includes a voiceover and a soundtrack.

Instructional/educational videos

These videos allow for the presentation of individual processes and the implementation of certain professional tasks. Graphics and diagrams are placed throughout the sequence to facilitate comprehension, with each video sequence lasting approximately 15 to 30 minutes. The material also includes a voiceover and a soundtrack.

Interactive scenario-based learning tools (decision-making game, SBL)

These games are based on interactive scenarios containing a plot description and rules defining the permitted and prohibited student behaviors during the game (Wong et al., 2016; Yilmaz et al., 2020). At certain points in the game, the player is tasked with making a decision affecting its further stages. In addition, the game provides an opportunity to develop and reinforce the learner's readiness to act, take risks and take responsibility for making decisions, but also allows for interrupting and resuming the game at any time. The participant receives feedback for both correct and incorrect decisions – followed by hints helping to make the correct decision.

In e-learning, it is worthwhile to use different types of multimedia resources in order to impart reliable knowledge. According to medical students, e-learning allows for the widespread use of high-end educational resources, serving as a reliable study support tool. While games and videos are relatively easily associated with multimedia materials (Szczeszek et al., 2023), seemingly less interactive content, such as documentation related to therapy planning, can also be successfully implemented in e-learning in the form of interactive documentation.

Interactive documentation

This component includes sample documents/forms, along with description instructions for its completion. It provides students the possibility to complete it on their own, get feedback on its completion correctness, and, in case of error, receive guidance on the correct completion of the form. The module incorporates examples of correctly completed documents.

Methodologically valuable elements of e-education include more elaborate multimedia and interactive materials, such as 3D animations, simulators and virtual tours. However, they require the work of a team with higher IT skills, often related to programming, and a subject matter expert. Given the time-consuming and costly nature of this process, it is advisable to create such resources on a nationwide level, rather than individually by educational units.

3D animation

This feature presents a 2D or 3D model depicting various aspects, such as the operation of equipment in a process, or the components of an item. It may contain various types of graphics that allow observation from different perspectives. It contains a textual or voiceover description of the object, including its construction, its operation or its mode of use. It demonstrates the performance of standard work activities and tasks, and the respective required equipment, including the outcome of performing the activity. The users can move and rotate the object around all axes. An audio track may be included in this type of media.

Simulator

This tool allows the student to carry out professional exercises, such as learning about the operation of a specific device or apparatus necessary to perform certain professional processes. It includes a description of the device's operation or construction, including interactive diagrams. It allows the student to independently

simulate activities involving the operation of the device, perform measurements or processes, select tools, interpret results, and troubleshoot potential malfunctions. A voiceover text or an audio track may be integrated.

Virtual tour

This functionality allows the student to see in detail the interior of given locations, through a guided tour of the facility, offering additional information. It gives the opportunity to get acquainted with the layout plan of the given premises presented in a graphic form (projection), as well as allows image manipulation (zooming in/out of the object). The virtual tour also includes a description of professional activities performed in the location, along with the identification of specialized equipment.

The next section discusses examples of the implementation of selected multimedia and interactive resources for teaching selected medical professions (Smelkowska et al., 2023).

All the illustrative material (figures 1–24) of the article are print screens of the multimedia and interactive material created within the framework of the EU project implemented by the Poznan University of Medical Sciences (all authors of the article are employed at the PUMS and participated in the project) and Lodz University of Technology – POWR.02.15.00-00-3051/20. The illustrative material is available on the website: https://zpe.gov.pl/szukaj?query=&stage=KZ&subject =bran%C5%BCa+opieki+zdrowotnej (license: CC BY-SA 3.0).

3. Examples of implemented e-materials

3.1. Medical sterilization technician

– a comprehensive look at the implementation of selected materials, such as simulators, animations, and instructional videos.

Simulators

For the profession of a medical sterilization technician, three simulators were created, providing students with a hands-on experience in operating a total of five different devices. These encompass an automatic washer-disinfector, a large steam sterilizer, a small steam sterilizer (autoclave), a plasma sterilizer and an ethylene

oxide gas sterilizer. The student, as a medical sterilization technician, virtually operates the device, from turning it on, testing its efficiency and setting process parameters, methodically arranging instruments and medical devices, packing them in sterile barriers, selecting process indicators, all the way to analyzing the printout and releasing the load. The simulator (Figure 1) is designed authentically to replicate reality, ensuring a seamless transition to real-world tasks (Rowan et al., 2023).

Figure 1. Simulator of the automatic washing and disinfecting device

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Interestingly, some of the most common errors and malfunctions (Smith et al., 2016) have also been integrated, which prepares the student to deal with them in daily practice (e.g., insufficient drying of tools, failure of the device to achieve the required physical parameters of the process, air-locking of components of the system supplying chemicals to the device chamber) – Figure 2.
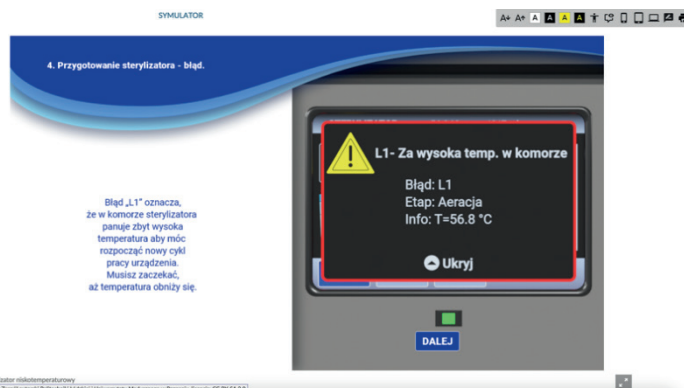
Figure 2. Low temperature – gas sterilizer simulator, error during the preparation of the device for operation

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The simulator gives brief instructions and explanations of subsequent steps, yet it incorporates stages where the student makes decisions. Examples include selecting the appropriate sterile barrier to pack the selected medical device, or determining the adequate tests and indicators to control the ongoing process. This further keeps the student engaged and requires him/her to recall knowledge gained from previous materials. The tool features visually captivating elements, enabling the student, for instance, to verify the results of biological tests and chemical indicators, such as observing the color change in the test field or bacterial medium. This aspect emphasizes the authenticity of the activity – Figure 3.
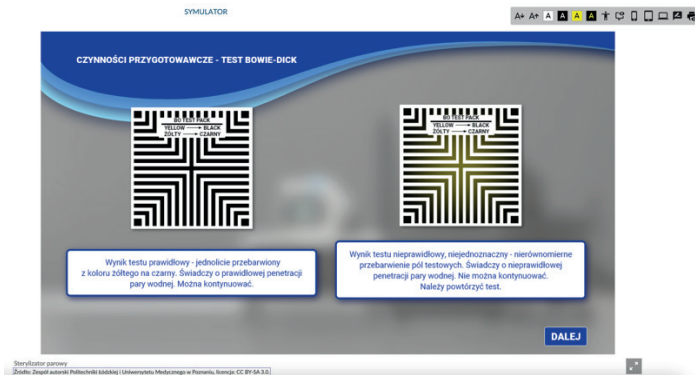
Figure 3. High-temperature-steam sterilizer simulator, Bowie-Dick test stained correctly and incorrectly

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Output documents from the device maintain authenticity and are useful in subsequent stages and at the process's conclusion. The analysis of these printouts is essential for determining the correct progression of the process and making informed decisions on whether to ultimately release the batch of tools.

3D animations

3D animations are examples of multimedia elements with attractive visuals. They present tools and medical devices in a 360-degree rotating view, while showing their assembly and disassembly. This process is very important for the proper preparation of medical devices for decontamination. The student can analyze the step-by-step assembly and disassembly of the device components in the correct order (Figure 4, Figure 5). The tool is complemented by a brief description of the construction and function of the device in question. Similar to the simulators, the graphics here also faithfully represent the structure and operation of medical equipment.

Figure 4. 3D animation 'Disassembly and assembly of medical equipment', Veress needle assembly

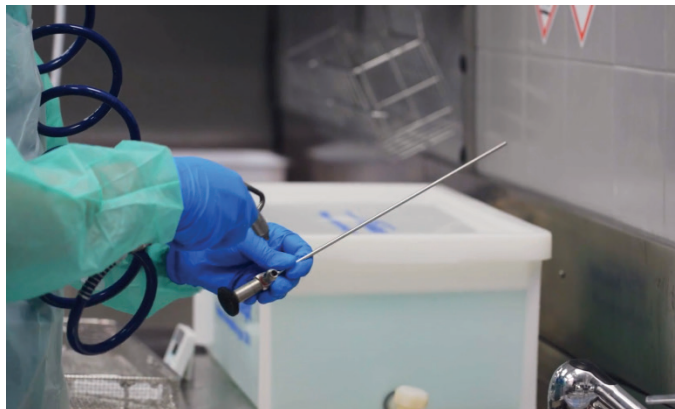S o u r c e: Project POWR.02.15.00-00-3051/20, license CC BY-SA 3.0.
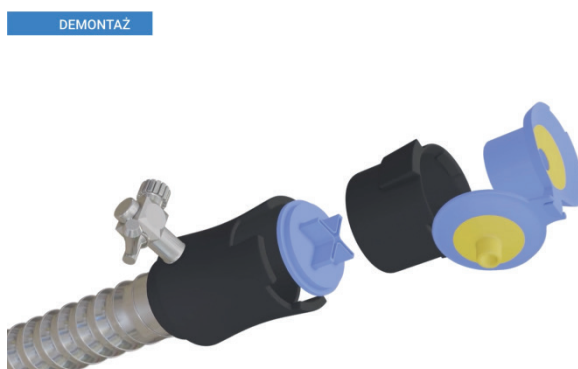
Figure 5. 3D animation 'Disassembly and assembly of medical equipment', disassembly of 12.5 cm laparoscopic troacar

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Instructional videos

A total of five instructional videos have been created for the profession of a medical sterilization technician. They describe and show in detail all the activities performed by a central sterilization room employee, covering the entire process from receiving contaminated instruments from the operating theatre to returning them to hospital units. It is worth noting that all the videos for this profession were carried out in the same central sterilization room, which gives the learner the additional opportunity to follow the layout of the rooms of the dirty, clean and sterile zones, along with the layout of the equipment and elements in each of them.

The videos also highlight the personal protective equipment required for each zone and activity, as well as detailed documentation of each stage of the process. Sample frames from the instructional videos are presented below (Figure 6, Figure 7).

Figure 6. A frame from the 'Machine and manual decontamination' instructional video

S o u r c e: Project POWR.02.15.00-00-3051/20, license CC BY-SA 3.0.

Figure 7. A frame from the 'Control of cleaning and disinfection processes, control of sterilization processes' instructional video

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3.2. Massage technician

– examples of implementation of selected materials, such as an educational video with 3D animations, film sequences and a scenario-based learning game.

Educational video with 3d animations

The main purpose of the presented educational video is to provide a spatial representation of the complex three-dimensional structure of one of the basic elements of the human body – the skin.

The video utilizes a 3D animation to delve into the intricacies of skin structure and the spatial arrangement of its elements (Figure 8). Students have the unique opportunity to learn about the layered structure of skin and the distribution of the relevant receptors in space. Through animation, the video vividly portrays the response of individual skin elements to specific massage techniques (Figure 9). This allows students to consolidate their knowledge of how individual receptors react to touch, but also allows them to visualize the effects of the treatment. The video additionally features a detailed voiceover commentary, which explains in detail the successive stages of the reaction. Students can stop watching the video at any time, take notes, or revisit a particular section of the material.
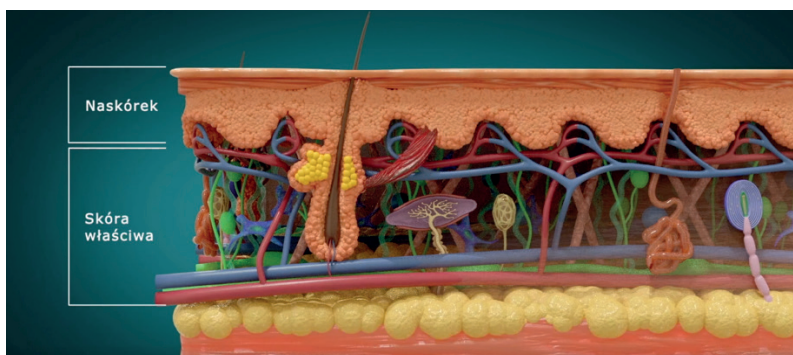
Figure 8. A frame from an educational video with 3D animations 'Skin Structure'

S o u r c e: Project POWR.02.15.00-00-3051/20, license CC BY-SA 3.0.
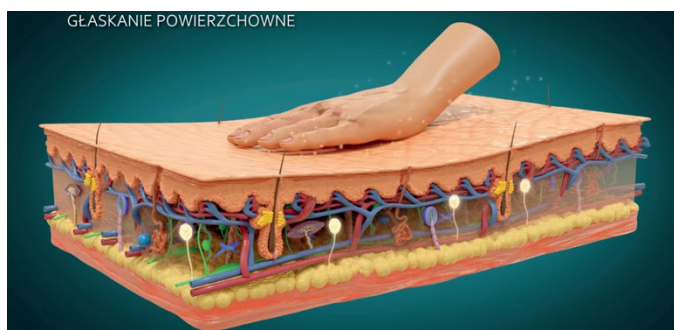
Figure 9. Frame from an educational film with 3D animations – 'Response of the skin and its elements to the technique of superficial stroking'

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For students with special needs, the video includes a detailed description of the elements on the screen, allowing even those with visual impairments to familiarize themselves with the material.

Video sequences

The video sequences are designed to give students a hands-on introduction to the entire process of manual lymphatic drainage, encompassing workstation preparation, patient setup, and the treatment of specific body parts. Due to the practical nature of the material, learners can familiarize themselves with the types of grips, the direction of each technique and their proper execution. Most of the material available to learners contains instructions on how to perform particular techniques or their elements. Our developed e-material takes a unique approach by presenting the application of manual lymphatic drainage techniques on a specific body area, illustrating the complete process rather than just its components (Figure 10). The material is additionally accompanied by a detailed voiceover commentary, which explains in detail how to perform each technique, as well as clarifies their clinical applications. Students have the option to pause the video and practically perform a given technique, in order to reinforce and consolidate their newly acquired skills.

Figure 10. Frame from a video sequence 'Individual techniques of manual lymphatic drainage performed on the thigh'

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Interactive scenario-based learning tool

While familiarizing themselves with the game, the students are introduced to two characters in the story – a massage therapist and a patient. As each scene is played, the learner is confronted with a series of decisions, the solution of which will affect the further course of the game. The learner's demonstration of knowledge, stress management capabilities, and comprehension of cause-and-effect relationships varies depending on the nature of the task, with each task being interconnected with other educational elements (Figure 11). The game also develops students' social competencies by posing problem-based tasks, such as coping with an adverse event during a massage. Students can solve tasks repeatedly by going through all the elements of the game, including interviewing the patient, prioritizing therapy, and performing individual techniques.
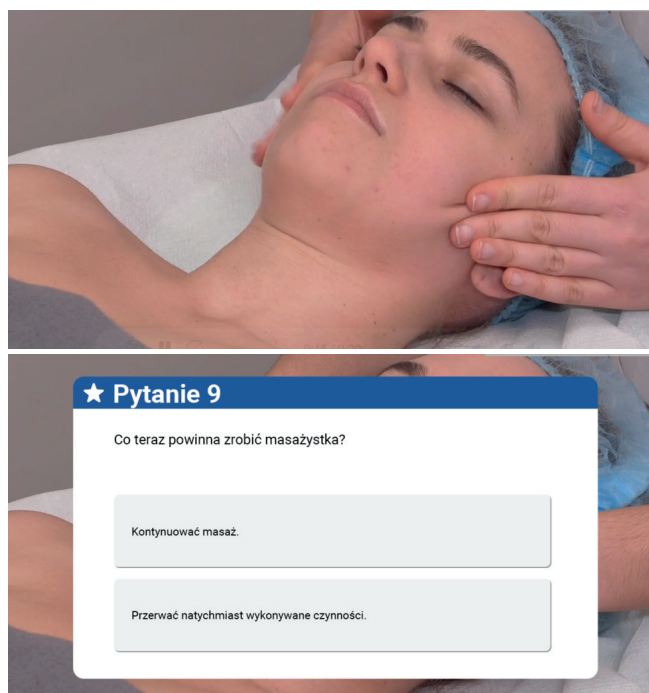
Figure 11. A frame from a video sequence 'Facial care massage'
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3.3. Occupational therapy

– examples of implementation of selected materials, such as a scenario-based learning game, film sequences and interactive documentation.

Interactive scenario-based learning tool

The game presented focuses on setting therapy aims. At the beginning of the game, the aims and rules are explained. Then, after selecting a patient, the player is given a detailed description (history of the disease, limitations, difficulties and the resources available to them), based on which they must make decisions that determine the therapy goals (Figure 12).

Figure 12. A description of the consequences of a good choice of a therapy aim based on a previous description of the patient's needs from the 'Setting therapy goals' game

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The choice of a goal has consequences that affect the patient's outcome (Figure 13). In the case of a wrong choice, the participant receives formative feedback, including a detailed explanation of why the choice was inaccurate, considering the indications and contraindications pertinent to the patient.

Figure 13. The figure presents a further description of the case after the previous correct aim choice

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In case of correct choice, the participant gains new information about the patient, needed to set further therapy goals. Through this approach the student gains the ability to plan therapy comprehensively, by analyzing information regarding the functioning of the person with a disability. They gradually learn about the elements of the patient's medical history and functioning relevant to therapy planning.

In the case of the SBL game, the content included allows the student to acquire skills in accordance with the learning outcomes. Students learn to set therapeutic goals for the patient, describe the individual and group forms of occupational therapy activity organization, select methods, therapy techniques for the patient in relation to his health condition, needs, problems and degree of disability, as well as adjust therapy to the psychophysical condition of the patient.

Video sequences

The sequences depict scenes of an occupational therapist's work in individual hygiene and housekeeping workshops, allowing the student to familiarize themselves with different forms of social skills training. The multimedia material helps the student expand their knowledge of health and safety rules for social skills training and acquire skills in creating scenarios that could be used in a daily living workshop. Example one: hygiene training – brushing teeth. (Figure 14).


Figure 14. A frame from the 'Hygiene and Housekeeping' video on hygiene training, during which a therapist instructs clients on how to brush their teeth properly

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The educational value of the material is further enhanced by supplementing additional information pertinent to the video content after each sequence. In the example in question, this includes safety rules to be followed when brushing teeth, advantages of taking care of oral hygiene and types of toothpaste. After each sequence, the student has to solve a short test task based on the content they were presented. The introduction of such an element not only adds variety to the content being conveyed, but it is also an important element in supporting the acquisition and consolidation of knowledge. The learner, when confronted with the task, has the opportunity to verify knowledge and possibly quickly return to the relevant content. Example Two: Training in the use of household appliances – washing clothes in an automatic washing machine (Figure 15).
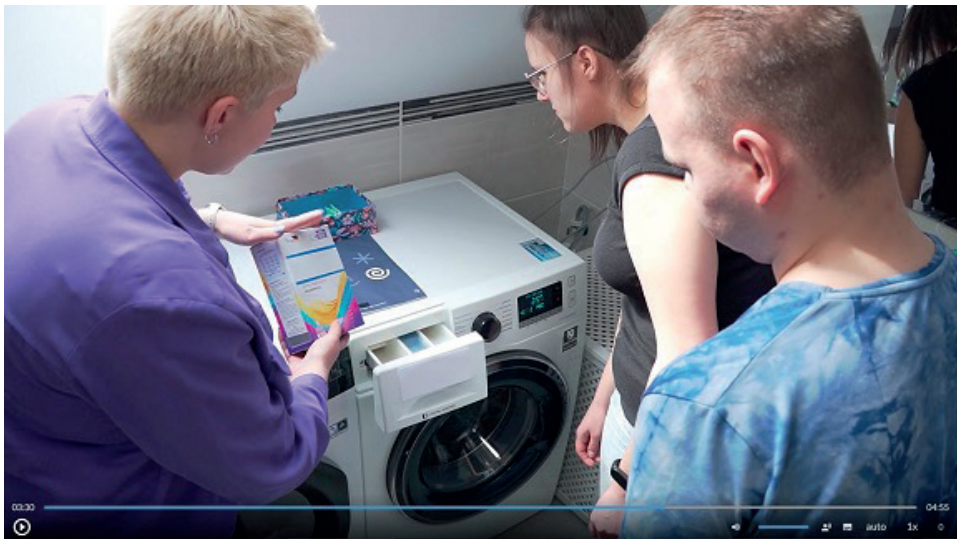
Figure 15. A frame from a video on housekeeping equipment training, during which a therapist instructs clients in operating a washing machine

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Similar to the first example sequence, the material contains additional relevant content, related to the required learning outcomes. The student has the opportunity to observe the correct execution of the training. They can return to the content and material unlimited times. The recorded educational content is reproducible and provides a model picture for the student.

At the end of the material there is a correctly completed scenario of classes for a group of adult Occupational Therapy Workshop participants. This scenario serves as a valuable source of knowledge and guidance for students undertaking individual work, offering a practical reference for their learning journey.

Interactive documentation

The student is assigned the responsibility of completing by filling out several interactive forms, each preceded by a set of necessary information. This necessitates the effective analysis of the provided information to accurately fill out the documents. For example, after reviewing the functional characteristics of a sample participant in a group therapy class – including the patient's physical, mental and social issues, their resources and capabilities, and the characteristics of their family and local environment – the task is to complete the section of the occupational therapy plan. This plan refers to the activation of the participant and cooperation with their family and local environment (Figure 16).

Plan terapii zajęciowej – współpraca ze środowiskiem rodzinnym i lokalnym

Korzystając z charakterystyki funkcjonowania Pana Michała Tamborskiego, uzupełnij część planu terapii zajęciowej odnoszącą się do współpracy ze środowiskiem rodzinnym i lokalnym uczestnika. We wskazanych miejscach formularza wybierz jedną z dwóch dostępnych opcji. W dokonaniu właściwego wyboru mogą być pomocne także wskazówki i informacje zwrotne podane w tym dokumencie.

Współpraca z rodziną		
Cele oddziaływań terapeutycznych	Działania	Częstotliwość
	• Organizacja zajęć otwartych dla rodziców • Wspólne warsztaty kulinarne dla uczestników i ich rodziców	Na bieżąco przez cały rok
Współpraca ze środowiskiem lokalnym		
Cele oddziaływań terapeutycznych	Działania	Częstotliwość
• Pozyskanie dofinansowania do remontu łazienki ze środków PFRON • Podniesienie komfortu życia rodziny • Adaptacja mieszkania – dostosowanie go dla osoby z niepełnosprawnością	Współpraca z poradnią psychologiczno-pedagogiczną Współpraca z powiatowym centrum pomocy rodzinie	Na bieżąco przez cały rok

Figure 16. An excerpt from the interactive documentation covering the part of the occupational therapy plan relating to the participant's activation, and cooperation with the participant's family and local environment

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In the next step, the student is presented with a daily schedule of activities in the occupational therapy workshop, another element necessary to complete the scenario of therapeutic activities (Figure 17).

Scenariusz zajęć terapeutycznych – fragment zawierający informacje ogólne

Korzystając z dziennego rozkładu zajęć w warsztacie terapii zajęciowej, uzupełnij część scenariusza zajęć terapeutycznych, w której podawane są informacje ogólne. We wskazanych miejscach formularza wybierz jedną z dwóch dostępnych opcji. W dokonaniu właściwego wyboru mogą być pomocne także wskazówki i informacje zwrotne zawarte w tym dokumencie.

Placówka	Warsztat terapii zajęciowej
Pracownia	Pracownia rękodzieła / Pracownia ceramiczna
Uczestnicy (imię i nazwisko, wiek)	Sandra Berent (28 lat), Tomasz Kulik (25 lat), Michał Walczak (19 lat)
Rozpoznanie	Niepełnosprawność intelektualna w stopniu umiarkowanym
Data	23.03.2023 r.
Czas trwania	
Temat zajęć	Ręczne lepienie miseczki z wałków i małych elementów gliny
Cel ogólny	
Cele szczegółowe	• Doskonalenie sprawności manualnej • Zwiększenie kontroli ruchów palców • Doskonalenie precyzji ruchów • Poprawa napięcia mięśniowego • Poszerzanie doświadczeń sensorycznych

Figure 17. An excerpt from a script of therapeutic activities, including background information

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While performing the tasks, the students receive ongoing feedback on the correctness of filling out the documents. They receive guidance on how to correctly fill out each document if they make a mistake, an important part of effective learning. The material also includes sample documentation, such as a completed occupational therapy plan and a scenario for group therapy classes. Each of the documents can be downloaded if necessary, offering considerable flexibility in utilizing the provided materials at one's convenience. Utilizing this virtual tool, students can plan the therapeutic process by using the information from the diagnosis. Moreover, they can learn to analyze recommendations of specialists and multidisciplinary team. This includes the ability to select methods of working with the patient, their family, and social environment according to the recommendations of specialists. Additionally, students can select suitable tools and aids, and formulate scenarios for therapeutic activities.

3.4. Pharmacy technician

– examples of implementation of selected materials, such as virtual tour, interactive documentation, and instructional video.

Virtual tour

By handling the virtual tour, the learner becomes familiar with the interior of a general pharmacy (Hookham et al., 2014). Students have the chance to explore the premises through a complete panoramic view, experiencing it from the perspective of an observer rotating on their own axis. They can navigate through the facility, look down and up, zoom in and out, and select the direction of the tour (Figure 18).

Figure 18. Interior of the warehouse of prescription medicinal products with description

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At the beginning of the tour, the student is introduced to general information about the operation of the pharmacy, such as the characteristics of the activities performed and the tasks of various staff. There are two ways to take a virtual tour of the pharmacy. The first one is to move around the facility by "entering and exiting" the respective rooms one by one. This allows the student to see how the rooms are interconnected. The second one is to tour the pharmacy by selecting a specific room from the attached floor plan with the layout of the rooms (Figure 19).
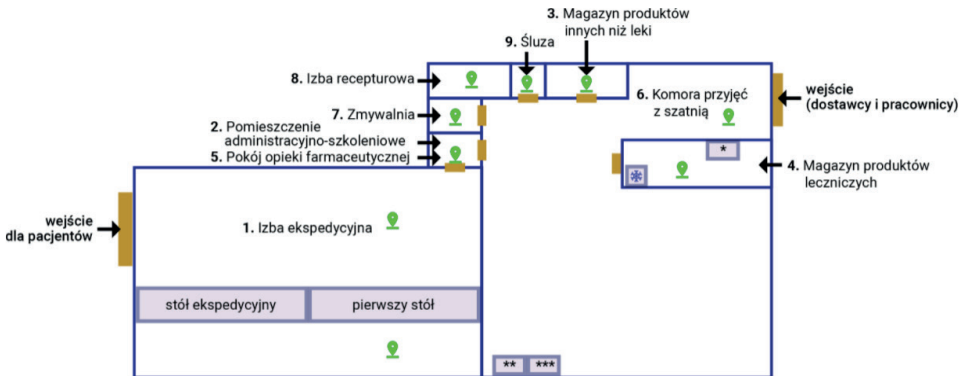
Figure 19. Floor plan of a public pharmacy with the layout of the premises

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The interactive bullet points are followed by descriptions of these rooms (their function, activities performed), and descriptions of the specialized equipment (Figure 20).
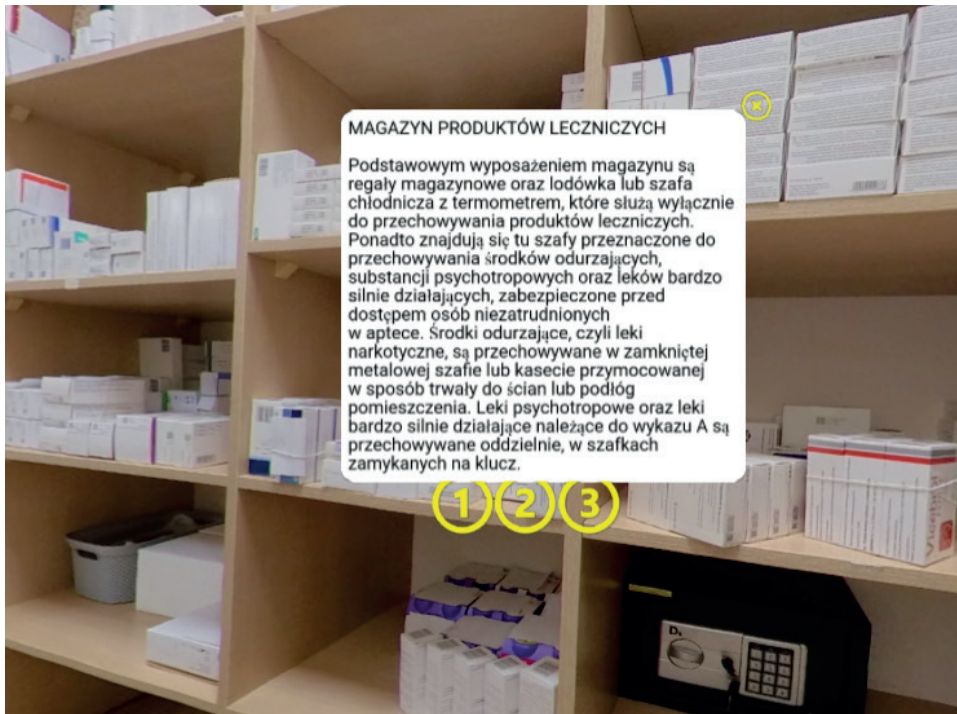

Figure 20. Interior of the warehouse of prescription medicinal products with description – the interactive bullet points

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Interactive documentation

Below is an example of an interactive medical record found in the profession of pharmacy technician. This includes documentation of adverse drug reactions, monitoring of the temperature range in the pharmacy, and the form for return and refund of goods in the pharmacy (Figure 21).

Figure 21. Excerpt from the Interactive Documentation 'Pharmacy Forms'

The form for reporting an adverse drug reaction is shown below, along with a case description and the necessary elements for its completion, as well as prompts for filling it out.

Case description: On 14.05.2022, a patient with the initials N.N., born on 25.04.1973, with a body weight of 69 kg and height of 177 cm, reported to the pharmacy. The patient declares that she is not pregnant. Since 1.02.2022, she has been taking a drug containing Atorvastatinum at a dose of 20 mg, according to a regimen of 1 tablet orally once a day. It turned out that since 15.04.2022 she started experiencing constipation, abdominal pain, bloating, nausea, headaches, itching of the skin and observed edema. The above side effects were mild. On 1.05.2022 she discontinued the drug, and the symptoms described above ceded.

Instructional video

The instructional video serves as a valuable source for the development of knowledge and skills in the practical aspects of a pharmaceutical technician's work in a pharmaceutical laboratory. Specifically, this type of media guides users through the process of conducting an analysis of ointment substrate viscosity, as well as assessing the dynamic viscosity of the ointment itself. The video shows the operation and use of the equipment-rotational rheometer – RS/CPS Plus (Figure 22). The video was recorded in the Department of Drug Formulation Technology at the Poznan University of Medical Sciences.
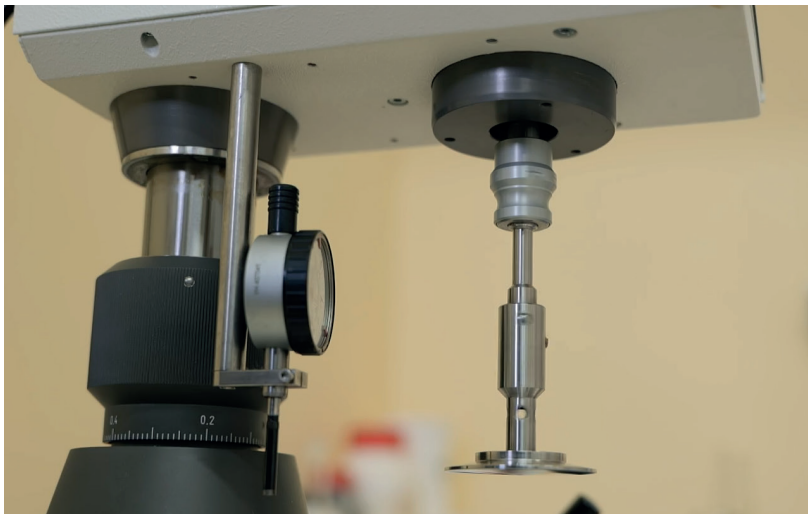
Figure 22. A frame from the instructional video 'Viscosity measurement of selected ointment substrates' showing the measurement system of a rotational rheometer

Based on the pharmacopoeial analysis, the students are introduced to the results and they can determine the average value of the dynamic viscosity of the pharmaceutical ointment (Figure 23, Figure 24). During the course of the video, included graphics and diagrams facilitate the understanding of the content presented, while a voiceover provides additional content.

Figure 23. A frame from the instructional video 'Viscosity measurement of selected ointment substrates' showing the start of the measurement

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Figure 24. A frame from the instructional video 'Viscosity measurement of selected ointment substrates' showing the presentation of measurement results

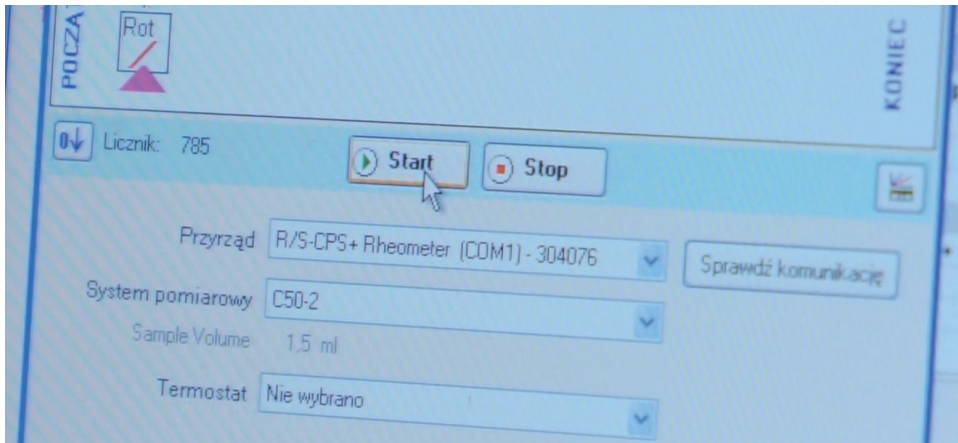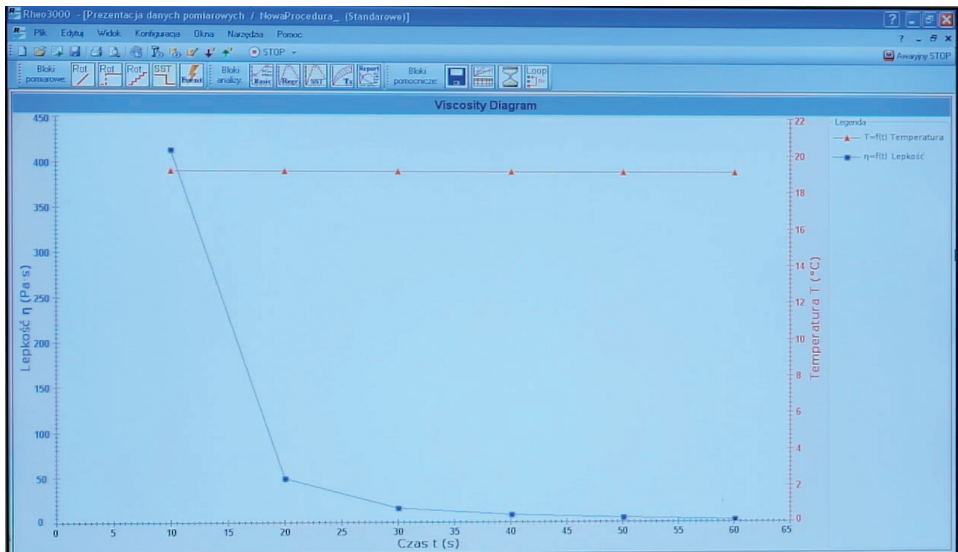S o u r c e: Project POWR.02.15.00-00-3051/20, license CC BY-SA 3.0.

4. Discussion

The section presents an analysis of teaching outcomes on the basis of prepared e-materials tailored for selected professions in the medical industry (Table 1, Table 2, Table 3, Table 4). In addition, it aims to formulate recommendations and guidelines for the design and creation of multimedia and interactive resources, paying particular attention to educational values and content (Leszczyński et al., 2020). This discussion is an integral part of the broader discourse on standards for developing innovative educational materials, with a specific focus on their application at the academic level, not solely within the medical industry (Kanikowska et al., 2023; Roszak, 2019). These recommendations are based on the extensive teaching experience of the project's authors, who possess considerable expertise in e-education development.

The deliberate inclusion of frequently recurring multimedia types across various professions is a noteworthy aspect. Their implementation, influenced by the specifics of a given profession and the presented content, demonstrates variations, which serves as an example and inspiration or effectively employing the same multimedia elements to achieve diverse educational outcomes.

Table 1.
Medical Sterilization Technician

e-material	e-material aim	Student benefit	Recommendations, indications
Simulator	Learning about and performing the process of operating equipment	• Independently performs each step of the process, • Availability of equipment used in central sterilization facilities, • Preparedness to proceed in the event of an error/defect in the equipment	Visuals representing reality are required
3D animation	Presentation of medical instruments and devices	• The ability to observe in detail (i.e., step by step and in the correct order) both the assembly and disassembly of instruments, medical equipment	Requires graphics that accurately depict the construction and operation of the tool
Instructional video	Presentation of the everyday activities of a central sterilization room employee	• Opportunity to see the everyday activities of the employee in detail • Familiarization with the equipment and its operation	It is important to demonstrate the complete process accurately

S o u r c e: Authors' own work.

Recommendations relevant to the multimedia presented in the medical sterilisation technician profession: realism (reflecting reality), detail (accuracy of the process), construction and functioning of the process/apparatus.

Table 2.
Massage Therapy Technician

e-material	e-material aim	Student benefit	Recommendations, indications
Education video with 3D animations	Spatial presentation of human skin	The opportunity to learn about the layered structure and distribution of receptors in space - understanding the response of skin elements to a given massage technique	High quality animation creation in close consultation with an industry expert is required
Video sequences	Presentation of how to perform manual lymphatic drainage	Getting acquainted with the complete procedure and all its elements	A detailed presentation of the process is necessary, from the preparation of the workstation to the completion of the procedure
SBL (Scenario-based learning)	Deciding how to perform a facial care massage	The possibility to go through all the stages of the treatment yourself, the possibility to see the correct massage technique	The game should be based on film material, Tasks should be based on cause-effect relationships

S o u r c e: Authors' own work.

Recommendations relevant to the presented multimedia in the profession of a massage therapist: detailed presentation, cause-and-effect tasks (reflecting reality), high production quality.

Table 3.
Occupational Therapy Technician

e-material	e-material aim	Student benefit	Recommendations, indications
SBL (Scenario-based learning)	Making decisions ad setting therapy goals	• Independent comprehensive therapy planning, • The possibility of making a mistake, without consequences for the patient, • Taking responsibility for the decisions made, • Showing the consequences of the decisions made	Decisions made should have consequences, which affects the fate of the patient

Video sequences	• Presentation of the work of the therapist in the hygiene and household task workshops, • Familiarization with the types of training in social skills workshops	• Presentation of an exemplary therapeutic process, • Acquisition of skills to create scenarios for a daily living workshop	After each sequence, the student should solve a short task that consolidates knowledge and adds variety to the content
Interactive documentation	Completion of interactive forms	• Independent planning of the therapeutic process on diagnosis, • Analysis of the recommendations of specialists and a multidisciplinary team, • Ongoing feedback on the correctness of the completion of documents	Should present realistic case descriptions, which affects the effective absorption of knowledge

S o u r c e: Authors' own work.

Recommendations relevant to the presented multimedia in the occupational therapy technician profession: realistic case descriptions, cause-and-effect tasks.

Table 4.
Pharmacy Technician

e-material	e-material aim	Student benefit	Recommendations, indications
Virtual tour	• Getting acquainted with the interior of a general pharmacy, • Getting acquainted with the activities performed in a pharmacy and the tasks of the staff of various positions	• The opportunity to see how the premises of the pharmacy are interconnected, • The opportunity to enter places that are normally difficult to access	It is worth to enable different ways to take a virtual tour, such as „entering and exiting" the rooms one by one or selecting a room from the floor plan
Interactive documentation	Completion of documentation related to adverse drug reactions, monitoring of the temperature range in the pharmacy, return and refund form of pharmacy goods	The ability to complete the documentation yourself and verify its completion.	Documentation should include a description of the case to give realism to the situation.
Instructional video	Demonstration of how to measure the viscosity of ointment substrates and determine the dynamic viscosity of ointments.	• Demonstration of operation and use of equipment, • Rotational rheometer, • Great detail, accuracy of presented process	Should include examples of actual measurement results

S o u r c e: Authors' own work.

Recommendations relevant to the multimedia presented in the profession of a pharmacy technician: diversity of message, real examples (realism).

Common recommendations in the design and creation of multimedia for healthcare professions based on the examples presented in the article

Regardless of the type of multimedia, the profession and the content, they should be based on a high level of detail of the presented process/situation combined with a high production quality. In addition, it is crucial to present real-life situations/cases that the learner will encounter in future professional work (realism of the situation). The level of interactivity and interaction in the prepared multimedia (task/action/decision-making) is also important, together with the cause-effect presentation for common everyday tasks in every profession.

5. Conclusions

Multimedia and interactive resources allow for a comprehensive and detailed presentation of the issues necessary for future professional work in the medical field. Through visual media like graphics, videos, and 3D animations, coupled with auditory components like voiceovers and sound elements, students actively engage in the learning process, reinforcing and verifying their acquired knowledge to immerse themselves in the role of a medical professional, meticulously performing the step-by-step tasks and activities integral to their daily practice. It is worth remembering that case study-based resources are a very important educational method, especially for the medical profession, where critical thinking and analytical skills are essential in clinical work (Allen et al., 2019).

The effectiveness of a multimedia resource in achieving learning outcomes varies, and not all outcomes can be met using the same e-material. In addition, creating e-materials requires to know the types of multimedia and interactive elements and their characteristics. It is important to remember that multimedia elements share the common characteristics of realism, interactivity and detail. Successful design and execution demand collaboration with subject matter experts experienced in e-learning production. Examples of the use of e-materials in various fields can provide inspiration and suggestions for their use in the education of other professions.

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Anna Smelkowska, Agnieszka Karbownik, Barbara Purandare, Katarzyna Zaorska, Marta Jokiel, Maurycy Jankowski, Magdalena Roszak

Interaktywne kształcenie asynchroniczne w edukacji medycznej w Polsce – wzorcowe przykłady

S t r e s z c z e n i e

W kształceniu osób mających wykonywać zawody medyczne bardzo ważne jest gruntowne przygotowanie merytoryczne i praktyczne. Dzisiejszy odbiorca wiedzy oczekuje różnego rodzaju zasobów multimedialnych i interaktywnych. W artykule omówiono przykłady takich realizacji dla ogólnopolskiego kształcenia technika farmaceutycznego, technika masażysty, technika sterylizacji medycznej, technika terapii zajęciowej. Tworzono je z myślą o zastosowaniu na Zintegrowanej Platformie Edukacyjnej Ministerstwa Edukacji i Nauki w Polsce w ramach projektu unijnego. Zde-

finiowano cechy charakterystyczne dla e-materiałów, takich jak: film instruktażowy i edukacyjny, sekwencje filmowe, gra typu scenario-based learning, dokumentacja interaktywna, animacja 3d, symulator i wirtualna ścieżka edukacyjna. Przygotowano analizę zysków dla uczącego się na bazie omówionych e-materiałów. Podjęto także próbę zbudowania zaleceń i wskazań przy projektowaniu i tworzeniu edukacyjnych zasobów multimedialnych i interaktywnych, zwracając szczególną uwagę na metody kształcenia i treści merytoryczne dla branży medycznej. Niezależnie od typu multimediów, zawodu i treści merytorycznych powinny one bazować na realizmie, interaktywności i szczegółowości prezentowanych sytuacji/przypadków. Nie wszystkie cele dydaktyczne i efekty kształcenia można zrealizować za pomocą tego samego multimedium. Aby dobrze zaprojektować i wykonać multimedia, konieczna jest znajomość ich cech charakterystycznych oraz praca zespołu ekspertów – autorów merytorycznych z doświadczeniem w tworzeniu e-edukacji.

S ł o w a   k l u c z o w e: edukacja medyczna, multimedia, zasoby interaktywne, e-materiały, ewaluacja, blended-learning, wideo, dokumentacja interaktywna, animacja, symulacja, wirtualne ścieżki edukacyjne, edukacja zdalna, technik sterylizacji medycznej, technik farmaceutyczny, technik terapii zajęciowej, technik masażysta

Anna Smelkowska, Agnieszka Karbownik, Barbara Purandare, Katarzyna Zaorska, Marta Jokiel, Maurycy Jankowski, Magdalena Roszak

Ejemplos de éxito de la enseñanza asíncrona en la educación médica interactiva a distancia polaca

R e s u m e n

Una preparación teórica y práctica exhaustiva es crucial en la educación de las profesiones médicas. El receptor actual de conocimientos espera diversos tipos de recursos multimedia e interactivos. En este artículo se analizan ejemplos de este tipo de implementaciones para la educación a nivel nacional de técnico de farmacia, técnico de masajes, técnico de esterilización médica y técnico de terapia ocupacional. Estos ejemplos se crearon para la Plataforma de Educación Integrada del Ministerio de Educación y Ciencia de Polonia, en el marco de un proyecto financiado por la UE. Se definieron las características de los materiales electrónicos, como vídeos instructivos y educativos, secuencias de películas, juegos de aprendizaje basados en escenarios, documentación interactiva, animaciones en 3D, simuladores y visitas virtuales. Se preparó un análisis de los beneficios para el alumno basado en los materiales electrónicos analizados. También se intentó elaborar recomendaciones y directrices para el diseño y desarrollo de recursos multimedia e interactivos, prestando especial atención a los valores y contenidos educativos para la industria médica. Independientemente del tipo de multimedia, la profesión y el contenido deben basarse en el realismo, la interactividad y el detalle de las situaciones/casos presentados. No todos los objetivos y resultados del aprendizaje pueden alcanzarse con el mismo multimedia. Para diseñar y producir bien los multimedia, es necesario conocer sus características y trabajar con un equipo de expertos en la materia con experiencia en el desarrollo de la educación electrónica.

P a l a b r a s   c l a v e: educación médica, multimedia, recursos interactivos, e-materiales, evaluación, blended-learning, vídeo, documentación interactiva, animación, simulador, visita virtual, educación a distancia, técnico de esterilización médica, técnico de farmacia, técnico de terapia ocupacional, técnico de masajes

A. Smelkowska, A. Karbownik, B. Purandare, K. Zaorska, M. Jokiel, M. Jankowski, M. Roszak

Анна Смелковска, Агнешка Карбовник, Барбара Пурандаре, Катажина Заорска, Марта Йокель, Маурици Янковски, Магдалена Рошак

Успешные примеры асинхронного обучения в польском интерактивном дистанционном медицинском образовании

А н н о т а ц и я

Тщательная теоретическая и практическая подготовка имеет решающее значение при обучении медицинским специальностям. Современный получатель знаний ожидает использования различных видов мультимедийных и интерактивных ресурсов. В статье рассматриваются примеры таких реализаций для общенационального образования по специальностям «фармацевт», «массажист», «техник по медицинской стерилизации» и «техник по трудовой терапии». Эти примеры были созданы для Интегрированной образовательной платформы Министерства образования и науки Польши в рамках проекта, финансируемого ЕС. Были определены характеристики электронных материалов, таких как учебные и образовательные видеофильмы, кинофильмы, учебные игры по сценариям, интерактивная документация, 3D-анимация, симуляторы и виртуальные туры. На основе рассмотренных электронных материалов был подготовлен анализ преимуществ для обучающихся. Также была предпринята попытка выработать рекомендации по проектированию и разработке мультимедийных и интерактивных ресурсов, обратив особое внимание на образовательную ценность и контент для медицинской. Независимо от типа мультимедиа, профессия и содержание должны быть основаны на реалистичности, интерактивности и детализации представленных ситуаций/случаев. Не все цели и результаты обучения могут быть достигнуты с помощью одного и того же мультимедийного средства. Для того чтобы хорошо разработать и создать мультимедиа, необходимо знать характеристики мультимедиа и работать с командой экспертов в предметной области, имеющих опыт разработки электронного образования.

К л ю ч е в ы е с л о в а: медицинское образование, мультимедиа, интерактивные ресурсы, электронные материалы, оценка, смешанное обучение, видео, интерактивная документация, анимация, симулятор, виртуальный тур, дистанционное образование, техник медицинской стерилизации, техник аптеки, техник трудовой терапии, техник массажа