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DIGITAL TRAINING GAMES AS COMPONENTS OF MULTIMEDIA EDUCATIONAL RESOURCE

Abstract. The article discusses the importance of implementing digital training games within multimedia educational resources. It is mentioned that training games support activating the process of learning the educational materials by the users with their being represented in a game form. The user is able to consolidate their knowledge by participating in digital training games. These games should be a component of integral multimedia educational resource that may be implemented in the form of multimedia complexes, interactive courses, etc., with multicomponent contents containing multimedia handbooks, training video simulations, interactive tasks, hints and advice, interactive tests, relaxation elements, etc. Thus, digital training games are considered an essential structural and substantial element of multimedia educational resource. Within the framework of the article, the composition of training and development functions of the games are determined. The reasonability of the development and placement of instructions for digital training games is justified, and the sequence of steps that may be used for game development is provided. Types of training games, implementing which in multimedia educational resources is reasonable, are suggested. For the purpose of approbation of the suggested types of games, the experiment with the involvement of 4th-year students specializing in «Publishing and Printing» in the form of an established all-around semester task in the «Technologies of Electronic Publishing» subject in terms of development of multimedia educational resources containing digital training games has been conducted. The results have provided an opportunity to make sure that all the types of games have had practical implementation in the multimedia educational resources of various subjective profiles developed by the students (both for mastering complex moments of subjects and for activating their self-development and self-studies in various living environments). In the article, every type of game is illustrated with author-developed examples of their implementation by the students. The materials of this article may be considered as a source of information for developers of multimedia educational resources with game elements.

Keywords: multimedia educational resource; digital training games; educational and developmental functions; basic step sequence; types of games.

1. INTRODUCTION

The problem statement. Multimedia educational resources (MERs) are integrated multi-component interactive learning tools used in the process of training/self-training of the users. They provide the possibility of a holistic presentation in the educational space of a certain multimedia product (for example, multimedia educational complex, interactive educational course, multimedia manual, etc.) of various educational media content and multiple interactive components, actively involving users in processes of training, self-training and self-development. MERs allow the users to study conveniently and according to convenient schedules, establishing their own trajectory of studies according to their needs and interests [1,

2]. The cores of such MERs are usually multimedia handbooks/textbooks containing interactive tasks, galleries, video lessons in the forms of passive and active video simulations, audio and video hints and advice, digital training games (DTGs), interactive tasks of various degrees of complexity, various instructions (for instance, for task performance or game or test completion), etc. [3]. It should be noted that using game elements plays an important role in the process of training/self-training of the users, ensuring the presentation of training materials in easy and interesting game forms. On the one hand, this ensures relaxing rest for the users, and on the other hand, it allows them to continue the training process by directly or indirectly approaching the issues of training materials in the game. Thus, in [4], the authors mention that digital training games influence the training process and should be adapted to the contents and integrated into the educational programs to establish students' theoretical and practical skills.

Therefore, DTGs should be essential elements of MERs (multimedia educational complex, interactive educational course, etc.).

Within the framework of this article, the attention is focused on namely training games implemented in digital/electronic format as elements of MERs.

DTGs contribute the intensification of cognitive activity and activation of the process of studies of the students and increasing the efficiency of understanding (due to the game visualization) the educational materials and consolidating their knowledge (due to the game form of presentation).

Analysis of recent research and publications. The analysis of research dedicated to the application of game elements during studies using electronic educational resources has provided an opportunity to learn that in the available [5] – [9] works, the authors have mentioned the importance of the application of games in the educational process of the users intending to study and widen their scope using self-development on certain issues. Thus, the authors of the [5] work mention games as an important component of training activity and suggest complex facts classification of electronic educational resources, in which the Educational category, the sign being Functions in the Educational Process, suggests «... (electronic training games...)», and the sign being Implementation of the Game Component – resources that contain/do not contain this component [5, p. 132-133]. The author of the [6] work defines games as a powerful educational technology that not only supports the activation of educational and cognitive activity but also supports the personal development of users during the educational process. By involving users in DTGs presented as independent interactive programs or interactive elements of MERs, one can support the acquirement of knowledge and skills in a certain branch [7], development of creative thinking [8], logic of thinking, spatial imagination, attention, memory, self-checking habit, increase of cognitive interest in studies, etc. [9].

In order to ensure the efficiency of studies using DTGs, the level of awareness of teachers in terms of their advantages is important as well [4]. For instance, in the [10] scientific work, the authors have researched the issue of DTGs being used by special education teachers in the Najran region while teaching handicapped students. On the basis of the processing of results of having enquired 96 teachers, it has been recommended to implement special educational programs for intensification of the development of abilities of teachers to use DTGs during the educational process.

It should be noted that while researching the issue of DTG application for the achievement of educational goals, within the framework of this article, our attention was focused on applying the gamification approach in MERs. As mentioned in the [11] work, «gamification applies the elements of games in non-game activity; for instance, for educational purposes». Such studying transforms the electronic educational environment due to the implementation of DTGs in it.

The positive influence of gamification on the interest and knowledge of the students and the educational process, which is demonstrated by the improvement of their educational

achievements, is described in the [12] – [15] research. For instance, in the [12] work, empiric evidence of mutual connections between knowledge, involvement, and satisfaction of the students is provided, which is important for the development of gamified studying design in the area of higher education. In the [13] work, the authors have researched the influence of gamification on the educational process in the educational environment of web programming, and attention has been paid to the behaviour and involvement of the students, considering their personal features.

It is mentioned in the 54 Gamification Statistics You Must Know: 2024 Market Share Analysis & Data article (in «Gamification in Education Statistics» [14], the chapter that contains educational statistics) that gamification in education leads to improvement of achievements, boosts motivation and makes studying more attractive (according to 67% of the students). The results of research by authors of [15] approve improved efficiency of studies of the students (the effect size being 0.504) due to the gamified approach in the educational context.

The empiric analysis of research on the influence of DTGs on the motivation of the students to study in three universities of Thailand performed in the [16] work has allowed approving positive influence on motivation increase via formation of more exciting educational environment. Positive results of the influence of digital games on the results of studies of the students, their motivation, involvement, and awareness in the area of online etiquette and responsible behaviour on the Internet have been received by researchers from China [17]. In the [18] work, the scientists from Kuwait conducted two-stage research on the influence of gamified education on the student's level of involvement and motivation. The result of the inquiry of 2nd-year bachelor program students approves that their involvement in studying is increasing, and integrating digital games on a quiz basis in the general engineering courses causes approving reaction of the students and supports the increase of their motivation.

Therefore, implementing digital/electronic training games in the structural and substantial contents of MERs is a powerful educational mechanism supporting the increase of motivation, increasing the involvement of users in studying, and influencing the improvement of their results.

However, it should be noted that most of the available DTGs are either individual software modules/solutions or inbuilt components of educational platforms without an opportunity to be used in the structural and substantial contents of MERs as their elements.

If it is about individual software modules for users to conduct gaming activities, these DTGs are often implemented using specialized online services and platforms, like LearningApps.org [19], Educandy [20], ClassTools [21], etc. For instance, the approach provided in the [6] work allows the creation of gamified industrial training lessons using the LearningApps software in order to create quizzes, Find a Match games, etc. This allows the creation of game educational exercises as separate interactive multimedia modules. They may be opened from the MER interface, like a page in a browser, for instance. However, this opening does not eliminate the issue that such modules are not structural elements of integral MERs. They are more auxiliary modules that cannot be placed alongside integrated interactive elements of MERs. It means that if the results of exercise performance are positive, the points received for it will not be added to the total accumulative results for the performance of interactive tasks, tests, video lessons, etc. Besides, activating a hyperlink from the MER interface to open such a task leads to exiting the MER / transferring to another resource containing this task from the MER interface, which violates the integrity of the educational environment of the MER.

In the [18] work, the Vortex-based online game developed using the ClassTools means is demonstrated, during which the students participate in quizzes in order to complete the game tasks. The purpose of the game is to familiarize the students with technical terminology on the

topics. The accumulated points are reflected in the leaderboard. The game may be used both during lectures and in free time when it is convenient for the student. Access to the game elements is provided on the course page in Moodle. However, it should be noted that such a form of study is still a secondary component of the educational process, where the main one is lecturing. Introducing game tasks to the structure of lectures would have been more reasonable.

If it is about independent software solutions, they either have a descriptive theoretic nature, like [22], or have a form of certain programs: [17], [23], [24]. The author of the [22] article considers the theoretical bases of using electronic didactic games and mentions that games with fixed structures support the formation of logical and mathematical competencies of preschool-age children while studying the mathematical concept of a set. However, no practical implementation of the game is provided within the framework of the article. At the same time, in the [23] article, there is an example of the creation of an educational board game for studying arithmetical operations, the Indonesian language, and natural and social sciences. The authors have visualized the stage of storyboarding and provided the structure of navigation, description of materials and examples of creation of multimedia objects and scripts. The results of testing the respondents approve the expected efficiency of the board game as a means of study.

Another interesting example is the Interland: Children's Safety on the Internet online game [24], which allows children to learn digital safety during their adventures in the game world, like how to distinguish fakes, fight cyberbullies, etc. The partners of the project are the Ministry of Digital Transformation of Ukraine, the Ministry of Education and Science of Ukraine, and the Diia.Digital Education national project. The online game is available on various devices. It should be noted that such a game resource is not an individual solution and may not be treated as a component of another MER; however, this does not exclude an opportunity for the MERs to include hyperlinks to it as to an additional resource for learning digital safety.

In the [17] work, a 2D digital game called QI the Alien Learns about Earth developed using the means of Articulate Storyline 3 is demonstrated. During the in-game activity, the students study digital etiquette and consolidate the corresponding behaviour on the Internet. It should be noted that considering the environment's functionality by which the game has been created, it may be either opened from the MERs or integrated into another MER project as its component.

The authors of the [25, p. 67-68] work have described the development of the Gimp Tools author game in computer sciences, developed in the MS PowerPoint environment on the basis of the Concentration template-based computer game. The purpose of the game is to study the Creation and Processing of Graphic Images topic by the students of Form 9. This is an independent game. It should be noted that, if required, the game may be integrated to the interface of the MERs developed, for instance, by means of the Adobe Captivate software environment.

It should be noted that DTGs may be implemented as inbuilt components of educational platforms, like the Edugames web resource [26] that contains a set of interactive game tasks in subjects like Mathematics, Ukrainian Language, and I Research the World. This resource is sustainable for use on its own and does not consider integration in another MER as its component. However, if required, it may be used as an additional useful educational resource.

Summarizing all of the above, it should be noted that opening another module / individual program / inbuilt games that are not included in the structural and substantial contents of the MER elements and may not be represented within the framework of its interface on other platforms:

1) makes considering points received for DTG performance on other resources while calculating the total accumulated points of the MERs impossible. The need to involve a

programmer arises if this is required, which is not a cheap option. In addition, an additional contract should be concluded if integration with the content from another resource is required;

2) leads to the requirement of exit/transfer from the unified integrated cover of MERs by partial location of the required educational resources beyond it. We believe that this is a violation of the organization of the unified educational environment of MERs.

When paying attention to the works dedicated to the constriction of MERs in the form of multimedia complexes, courses, etc., it should be noted that some of them have raised the issue of reasonability of the inclusion of game elements to their structure, and implementation of this has been provided.

For instance, in the [27] work, instructions for multimedia developers and users of electronic training are suggested. They allow an understanding of what should be considered during the creation of resources for digital training and how to use the potential of such resources (particularly of the games for online training) to the utmost.

During the formation of the concept of creating multimedia tools for the educational environment of dual education for the Publishing and Printing specialty, the author of the [2] article concentrates on the elements of multimedia complexes belonging to certain knowledge categories. This ensures support of a competency-based approach. Imitation Games are categorized as Informal Knowledge of Activity and Its Results and Underformalized Regulatory (Operational) Knowledge, which is going to be implemented the most by the game during the formation of competence-based components of users.

In the [28, p. 212] scientific article, in the contents of the description of the module-component structure of support of student-centered studies in terms of Publishing and Printing specialty, the component 6 (Emulation and Simulation of Objects and Processes) is mentioned as allowing implementing “studies via imitations and simulations...”. In our opinion, the functionality of the component requires further expansion not only due to the implementation of interactive video lessons but also due to the implementation of interactive game training tasks in the form of simulation training exercises for acquiring professional competencies.

In the [1] work, special features of the content structure of a multimedia training complex for establishing competencies in the Colour Theory subject, implemented as a network resource with the CMS Joomla means, are provided. The description of components of illustrative and descriptive, reproductive, and creative levels of the complex is provided. However, this work does not contain any game elements, which determined the reasonability of further expansion of the reproductive and creative levels of the complex.

In the [29, p. 119-121] work, experts are offered to evaluate the reasonability of the application of 31 alternative ICT ways for the formation of research competencies of high school students during the profile studies of chemistry. The expert examination results have determined that the way of training games in chemistry is reasonable for forming research competencies (the indicator of relevance being 0.74).

Works with our own exploratory studies ([3], [30], [31]) are dedicated to the issues of analysis and justification of reasonability of inclusion of various types of structural elements (including DTGs) to MERs and implementation of game functionality in MERs. Thus, in one of the chapters of the Economic and mathematical basis for development of the multimedia educational publication Colour Theory monograph [3], the methodic allows resolving the scientific task of determining the most reasonable structural contents of the Colour Theory MER via the competence component is suggested. The reasonability of implementing interactive minigames as parts of the Colour Theory MER is justified. The following games are implemented [3, p. 145-146]: based on assembling topical jigsaw puzzles with time limits and control of performance correctness, item colour and shape matching, and placement of coloured rectangles on a stage in correct proportion.

In the [30] research, the methodic of determination of the most reasonable structure elements for the purpose of creation of multimedia publications in the form of self-instruction manuals for teaching primary school-aged children to play the piano is provided. Educational minigames have become one of the structural elements for its implementation [30, p. 191] (their total efficiency being 8.616 and weight being 0.16), as well as the Minute of Resting relaxation space implemented in the game form (its total efficiency being 5.842 and weight being 0.11), recreated by means of Adobe Captivate within the framework of the Self-Instruction Manual of Playing the Piano MER.

In the [31] scientific article, during the resolution of the task of conducting the comparative analysis of analogues of the developed multimedia training course, the criterion of the existence of training interactive games has been determined as a part of the criteria base. The authors have assumed that if the required functionality is not implemented in the existing analogues, defining the requirements for the inclusion of new functionality in the multimedia course is reasonable. The game element is included in the structural scheme of the Succulent Care multimedia training course and has practical implementation. The Correspondence with a Friend game is a structural and substantial element of an MER for the self-development of users in terms of plant care. It allows receiving important advice in terms of correct succulent care in the process of communication of users with a virtual friend.

In the [32] work, the authors have developed a cyber literacy training course for secondary school students that contains the Rescue web game. The game has been implemented on the basis of using the ACRS model and the quest room concept. It has been presented by means of the Articulate Storyline 3 environment with location on the Tencent cloud server. The performed experiment has shown that the users who have studied cyber literacy on the web game basis have had better results and higher motivation than those who have studied according to the professional form.

In the [33] work, the model of gamification of digital content for a printed book is suggested. In the research, the platform architecture of the Moodle educational environment, in which game activities to the books are created with the H5P and Game gamification plugins are created, is suggested. Courses developed on Moodle correspond to printed books, which are supplied by a forum and a game set. The digital contents and interactive activity determined for educational goal achievement supply the actual work with books.

The opportunity to use game content is implemented in the Storytelling for Youth Work [34] multimedia manual which contains educational theoretical and practical materials for young workers. It includes descriptions and inbuilt links to digital simulation and role-playing games. The contents of the games correspond to certain educational requirements, allowing users to learn how to cooperate, resolve problems, determine their priorities in dangerous situations, etc.

“Determination and description of models of editorial and publishing preparation of projects of multimedia interactive textbooks...” has become the goal of the [35, p. 86] work. The author of the work described the e-textbook of the Rozumnyky multimedia publishing house, in which interactive tasks are implemented as minigames according to the topics with the visualization of the Owlet character if the tasks are fulfilled correctly.

Modern innovations in the application of new technologies for developing educational games necessitate the inclusion of new technological operations in the technological chain of MER creation processes. These include, for example, the game development using artificial intelligence tools [36, 37]. GlobalLogic engineers note that this: “...makes it possible to create the character and language of game characters using generative AI” [36]. This simplifies the development of game dialogues. There is no longer a need to meticulously script all possible response options for the characters, as we did in the Correspondence with a Friend game [31] for each interaction scenario between a virtual friend and the user of a multimedia educational

course. We believe that using AI in the creation of dialogue-based games could be a direction for further technological improvement of some of the DTGs we have developed in [30, 31].

In study [37], the authors explored the potential of using interactive educational games developed with ChatGPT in contemporary education. Relevant experiments are presented that demonstrate the application of ChatGPT for creating DTGs with interactive scenarios and differentiated, adaptive feedback. The authors emphasize that such games are advisable to integrate into learning management systems.

The implementation of a topical creative minigame, where users can draw something using the means of an inbuilt graphics editor and feel like a designer, is provided in the [38] work as the relaxation game block of the Graphic Design MER.

However, we note that the quality of implementation of the design of the game component of MER Graphic Design could be significantly improved by taking into account the modern trends of the influence of Reflective Game Design on achieving the goals of digital game education. The importance of taking such influence into account is evidenced by the results of the study of digital games from the standpoint of their reflective nature, given in [39], which allows designers and developers to create more effective DTGs.

While summarizing the conducted analysis, it should be noted that available MERs are generally open to be expanded with game elements. Certain multimedia components in the form of game activities are present in the contents of the analyzed MERs. However, it should be noted that in most of the aforementioned works, it has not been emphasized that DTGs should be fully featured elements of MERs. The authors have not paid any attention to consideration of the educational and developmental functions of DTGs; the sequence of development of DTGs as elements of MERs has not been determined and types of DTGs reasonable in terms of reproduction within MERs have not been indicated. These issues have been left open, which indicates the applicability and reasonability of their exploring them within the framework of consideration of DTGs as elements of MERs.

The goal of the research the definition of educational and developmental functions, the basic sequence of development, and the types of DTGs appropriate for implementation within the elemental structure of MERs.

In order to achieve the set goal, the following tasks have been resolved:

- 1) definition of educational and developmental functions of DTGs that MERs users should develop while using them;
- 2) determination of the basic sequence of steps that may be used for the development of DTGs as structural and substantial components of MERs;
- 3) definition of types of DTGs, implementation of which in MERs is reasonable, and provision of examples of their practical implementation by the students within the framework of multimedia complexes/courses, etc.

During the preparation of the article, the personal practical experience of the authors in terms of the development of MERs for various topical areas dedicated to structural and substantial organizations, content fulfillment, and practical implementation of integral online/offline multimedia training complexes, courses, and their interactive game component has been reflected.

Within the framework of this article, the direction of activation and support of studies / self-studies and self-development of users with DTGs as elements of MERs has been developed.

The research is based on using the following methods:

logical analysis (for studying theoretical and practical special features of application of DTGs during the training of the users);

system analysis (to definition educational and developmental functions, determine the basic sequence of DTG development and determine the types of DTGs, the implementation of which in the MERs is reasonable);

pedagogical observation and pedagogical experience (for approbation of the suggested types of DTGs in MERs within the framework of the all-around semester task in the «Technologies of Electronic Publishing» subject;

survey (to collect and analyze feedback on the use of a multimedia educational complex with gaming elements by second-year students of the "Publishing and Printing" specialty, designed to simplify mastering the art of programming in C# as part of the course "Programming Multimedia Tools").

2. RESEARCH RESULTS

2.1. Functions, basic creation sequence, and types of DTGs

DTGs are directed at the improvement of the process of acquirement and understanding of the educational material of the MERs with game elements. They help users understand certain events and processes and positively influence personal and professional development due to cognitive, search, etc., nature game actions.

Such games should be considered a powerful component of the structural and substantial contents of MERs that is going to support the increase of the degree of understanding and acquirement of educational material by the users. In order to ensure the integrity of the educational idea of provision and fulfillment of certain functions, DTGs should correspond to the topical areas of MERs and the materials of their chapters/topics.

On the basis of processing the substantial load of functions of game technologies and functions of electronic training game resources determined in the [9], [23], [25] works, we have accentuated the following important educational and developmental functions of DTGs that they should activate, support and develop in terms of MER users:

1) development of logical thinking on the basis of the performance of game actions in terms of sorting, matching, and finding certain objects according to the conditions established in the game, etc.;

2) development of the system and spatial thinking on the basis of determination of the integrity of structures in the forms of certain objects, spatial identification of objects/events, etc.;

3) development of strategic thinking on the basis of development and training of idea generation abilities and planning of the sequence of actions determining various scenarios of user behaviour in order to complete the game;

4) development of analytical thinking on the basis of processing the information according to all the conditions, assumptions, limitations, etc., in order to make a correct decision and conduct corresponding actions (of calculative, design, etc. nature);

5) development of creative thinking due to providing users with an opportunity to show their talents by conducting actions in the game without determination of their correctness and assessment of the results (for instance, to draw something in a certain style, etc.);

6) development of communicative thinking and socialization on the basis of simulations, etc.

It should be noted that in order for the mentioned DTG functions in MERs to be implemented, interesting and pleasant unforced game feeling increase the level of motivation of users and support enhancement of their intention to play, achieve training results, and learn something new, as well as to make everything that users have just learned in the multimedia publications in understandable game form clear, should be implemented.

For everything to be clear to users (the goal, the game rules, the actions they should conduct, etc.), the instructions for the game should be available in the MER interface before the game begins. It is mentioned in [18] that the game should have definite instructions.

It should be noted that instructions may look like separate pages with text descriptions or provided as video explanations, audio hints, etc. An example of what instructions with text descriptions may look like, and a fragment of an digital game window is provided in Fig. 1. It has been implemented on the page of the Human Anatomy Course: Locomotive System (concept by Khoroshevskaya Iryna, design, media content and technical implementation by the student Havlenko Yaroslava) multimedia educational manual.

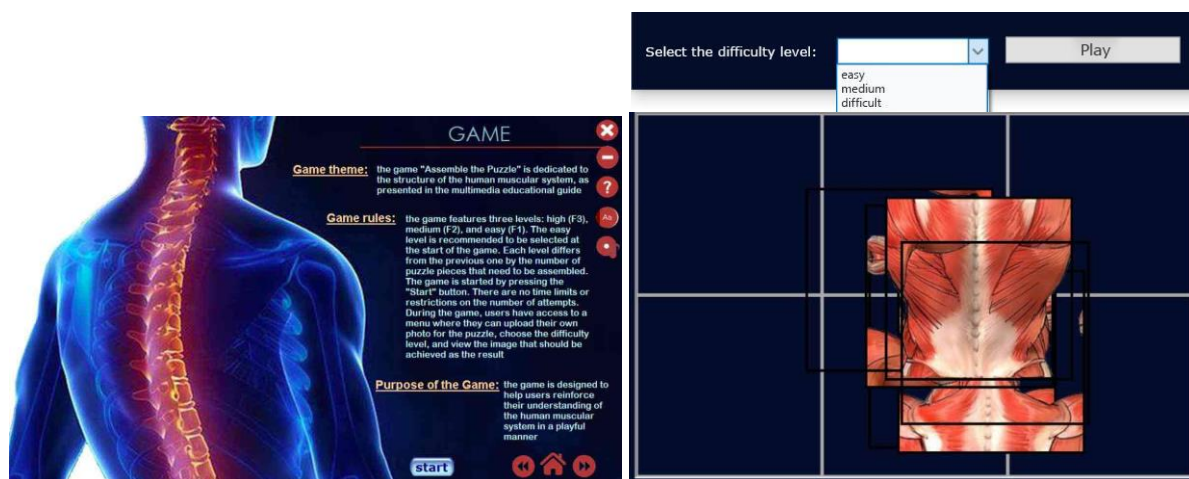


Fig. 1. Example of an instruction to a digital training game and its appearance (Easy level)

DTGs may be located in the MER structure as separate game blocks or inbuilt on the pages of multimedia manuals/textbooks as the main elements of MER immediately after a certain chapter/topic is laid out. If DTGs are built into the pages, such publications are notable for their high level of interaction with users. Thus, learning the MER materials takes place due to what users have just learned, and its playing takes place immediately in an unforced game form. This way, users have an opportunity to consolidate their knowledge better while playing. This provides a higher level of understanding and memorizing the material due to the fact that users do it on their own, think over their results, analyze them, and are determined to make them better. This way, the experience acquired in DTGs becomes the users' personal experience.

However, DTG creation is not a simple process. It is related to working out the logic of the game, creating scenarios of its implementation, determination of possible results, etc.

In exemplification of this, here is a basic sequence of steps that may be used to develop an digital training game as a MER component:

- 1) determining the location of the training game in the MER (as a separate component accessible, for instance, from the main menu or located after the issue of the educational material being reproduced on this / the separate page). It should be noted that within the framework of this article, accessing the game by following a link to external resources/game platforms (leading to transfer from / exiting from the MER interface) is not considered. This is made in order not to violate the integrity of the MER and to provide an opportunity to implement the pedagogical scenario, according to which the points acquired by the user for the DTG may be added to the total number of points for studying the educational materials (tasks, video lessons, tests, etc.) of the MER;

- 2) defining the idea and determining the type of the digital game;

3) determining the name, goal, purpose, tasks, and rules, as well as if there are limitations and access to the game, and defining them;

4) selecting the form in order to compose the game scenario (most often, it is a verbal or graphic form) and developing it;

5) describing all the objects and processes that are going to be involved in the game, considering that the game may be based on a set of components; for instance, interactive elements, video and audio hints, graphic elements, text blocks, etc.;

6) suggesting the design of the game interface and its elements (at the same time, the graphic and colour appearance of the objects, processes, and events should be identical to their appearance on the pages with the MER educational material);

7) conducting the step-by-step process of game creation in the development environment along with setting the characteristics and parameters of the involved elements;

8) implementing the script structures, if any are considered (like scripts for visualization of certain bonus contents in case of winning the game);

9) testing the game and eliminating the discovered defects (this may be content-related, functional and ergonomic testing);

10) demonstrating (with access from the MER) the results of the digital training game in case the user wins or loses it.

One of the important issues of the game development process is the determination of the game type, which is the vector of its ideological and logical structure.

The game type determines what users should do in it: match the objects, find something according to the provided condition, sort the objects according to some characteristics, analyze the information and take decisions, create the action strategy, interconnect during virtual communication, etc.

Now let us determine the types of DTGs, implementation of which in MERs is reasonable. To do so, the existing ideas, approaches to organization and direction, etc. of digital/electronic training games described in the [6], [9], [17], [18], [23], [25], [27], [32], [35] works, which are interesting in terms of their development and implementation in the topical area of game training of users in the environment of multicomponent MERs, have been analyzed. They have been used as the basis for the determination of the DTGs types suggested in this article to be implemented within the MERs.

The following DTGs have been classified by us as those implementations of which in MERs is reasonable:

1) *matching games* determined at conducting actions with all the objects/items available on the page for the purpose of their correct logical matching/correspondence to each other. Such games may also be directed at grouping all the provided objects/items according to certain areas, layers, etc., in accordance with the established features;

2) *selection games* determined at a correct selection of a certain number of objects/items out of the set provided in the game area in accordance with the established condition;

3) *searching games* determined at searching for objects/items in accordance with the established condition (for instance, having the same certain feature, like appearance, size, etc.);

4) *solution games* determined at the provision of correct answers on the basis of logical, calculation, design, etc. operations;

5) *sequence games* determined at fulfillment of tasks of figuring out the correct sequence of objects/items (for instance, during their sorting, determination of the sequence of actions to initiate a certain procedure, etc.);

6) *jigsaw puzzle games* determined at fulfillment of tasks of assembling a whole structure out of various elements (parts, details, etc.);

7) *riddles, puzzles, quests, quizzes, crosswords*, etc., in which users need to guess or solve something, to sequentially fulfill certain tasks / select certain actions, the results of which

influence the course of events or to provide correct answers to the questions, which are then going to be placed in the specific place in the field, like, for instance, in crossword games;

8) *games with plots of certain genres* (detective, humour, adventure, etc.);

9) *strategy games*, the goal of which is teaching users to analyze, plan and make decisions on the basis of the development and implementation of certain user behaviour strategies;

10) *creative games*, in which users may show their abilities, creativity, etc., in various topical areas according to the thematic scope of MER;

11) *dialogue communication games*, in which users may virtually contact and communicate with virtual friends by, for instance, correspondence, and receive answers and advice to the questions they are interested in from these friends;

12) *simulation games* allow acquiring practical skills by virtual imitation of interactive interaction with the objects/items needed for studies of users.

It should be noted that the suggested set of DTG types, implementation of which within the framework of multimedia resources in the forms of complexes, courses, manuals, etc., for user training is reasonable, is an open set with an opportunity of their clarification, expansion, and adaptation according to the specificity of the topical areas of the created MERs.

Therefore, including game elements in the MER structure ensures support of the process of training and self-development of the users via game tasks, imitation and simulation games, crosswords, jigsaw puzzles, topical game relaxations, etc.

2.2. Practical implementation of DTG types

For the purpose of approbation of the idea of relevance and reasonability of practical implementation of the suggested DTG types as parts of MERs, within the framework of the Technologies of Electronic Publishing, the 4th year students of Simon Kuznets Kharkiv National University of Economics have been given the all-around semester task of MER development according to the topical areas selected by them. Development of one / several DTGs of any type should have been considered in the MERs. 146 students specializing in «Publishing and Printing» have taken part in the experiment.

Then, the visualized examples of their practical implementation within the framework of the MERs developed by the students have been demonstrated in terms of every DTG type. All the examples are author developments of the 4th year students in the light of representation of the experiment idea:

1) an example of a matching game, where users should click on the images, listen to the alarm sounds, and match them with their meanings by dragging them to the areas under the corresponding images, is provided in Fig. 2:

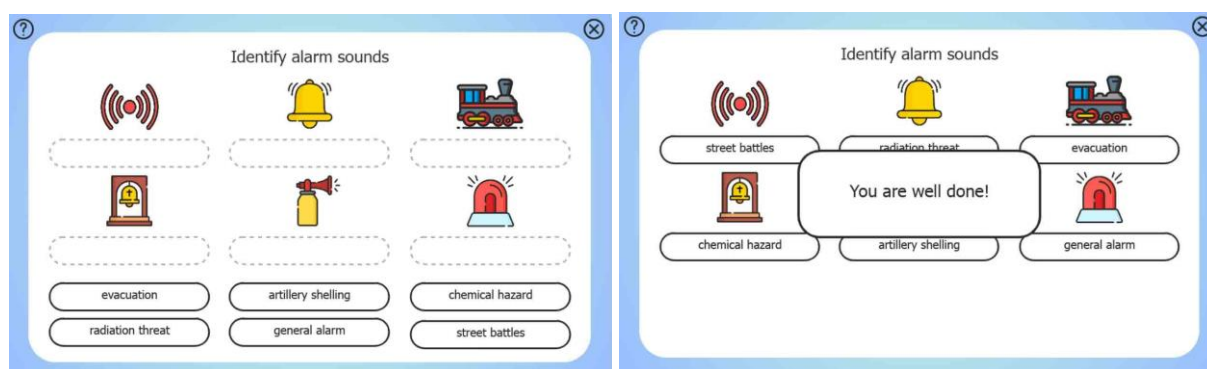


Fig. 2. Recognize the Alarm Sounds matching game as the element of the Guardians of Safety: Important Rules during the War MER (student Vorobiova Yelyzaveta)

2) an example of a selection game, the goal of which is the determination of the correct associated words only from the set of 14 possible words corresponding to certain colours, is provided in Fig. 3. Users should drag all the correct associated words to the coloured areas:

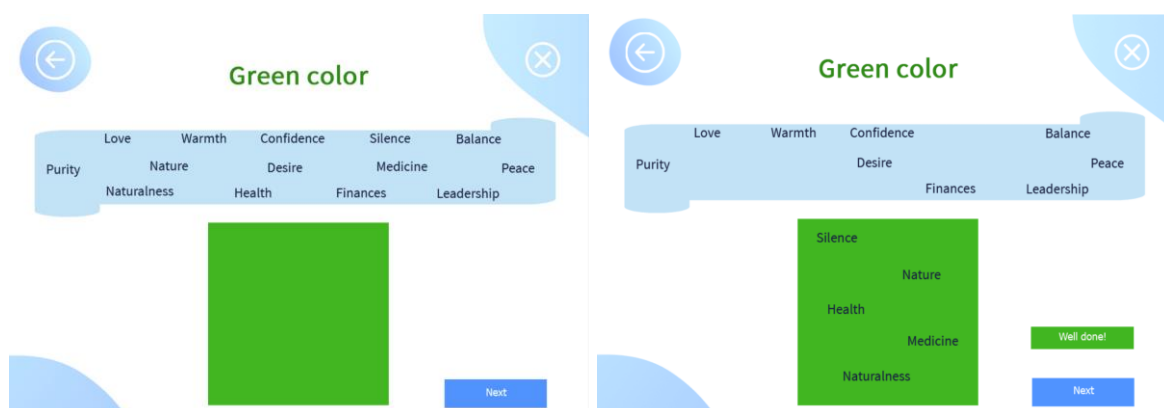


Fig. 3. Colour Associations selection game as the element of the Studying the Basics of Design MER (student Chernova Mariia)

3) an example of a searching game with the task of finding identical images for the purpose of developing the skill of searching for identical objects is provided in Fig. 4:



Fig. 4. Find a Match searching game as the element of the Educational Publication for Preschool-Age Children MER (student Habriielian Alina)

4) an example of a solution game, the goal of which is the calculation game task, on which users think, shape their answers, and then check their correctness on the Checking tab, is provided in Fig. 5:

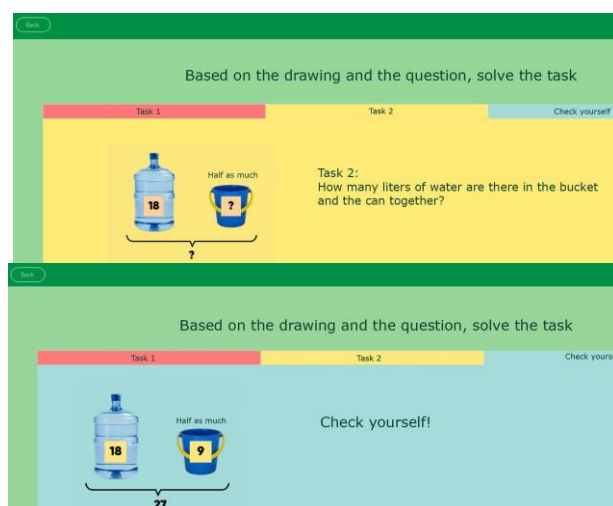


Fig. 5. Mathematics for Form 3 solution game as a MER element (student Yarmilets Yelyzaveta)

5) an example of a sequence game, the goal of which is determining the correct colour sequence of the location of traffic light signals, is provided in Fig. 6:



Fig. 6. Traffic Lights sequence game as the element of the Traffic Rules for Children MER (student Yefimenko Olha)

6) an example of a jigsaw puzzle game, the main idea is assembling a character image out of separate layers in the correct order is provided in Fig. 7. It is considered that players can only move one element of the character in one move. If users assemble the whole image immediately, this is considered to be a mistake because this is a violation of the goal of the game, which is helping users to learn the hierarchy of layers for the purpose of work in Unity:

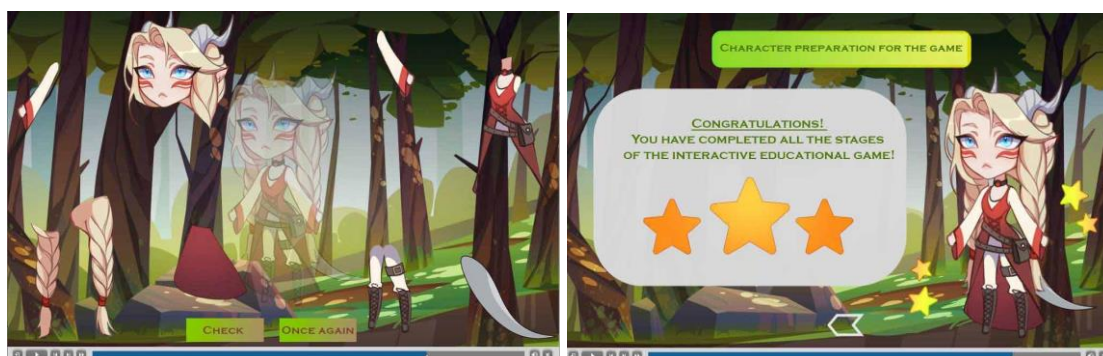


Fig. 7. Assemble a Character jigsaw puzzle game as the element of the Character Development for the Game MER (student Dmytrenko Yelyzaveta)

7) an example of implementing a crossword game, where correct answers must be provided based on the study of the JavaScript programming language, specifically the "Functions" module, is shown in Figure 8. If the answer is correct, it is placed in the corresponding field of the crossword:

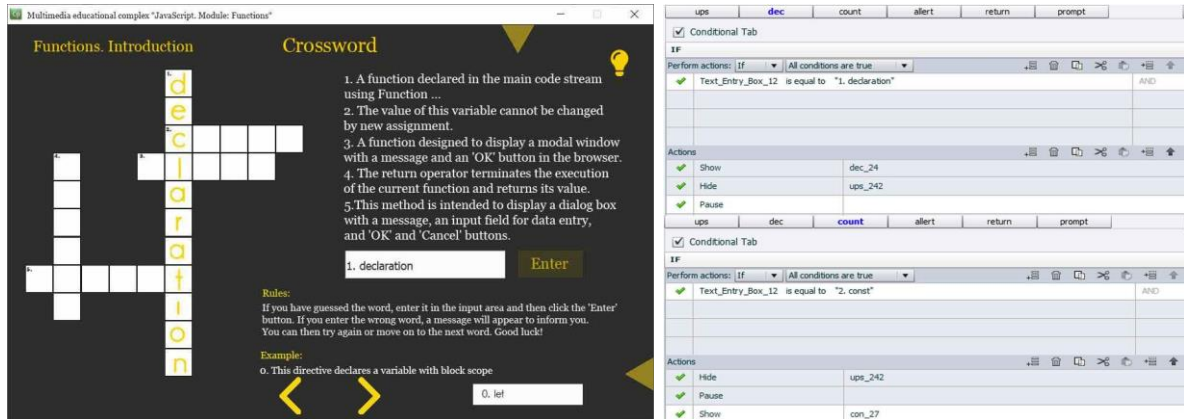


Fig. 8. Smarty crossword game as the element of the JavaScript. Module: Functions multimedia educational complex (student Myshakova Alina)

8) an example of an adventure game in which users travel along the suggested way, moving from one location to another to an unknown island where the treasure is hidden, is provided in Fig. 9. At each of the locations, users are suggested to fulfill interactive tasks in programming at the C# level of various difficulty levels by providing answers according to the suggested listing fragments:

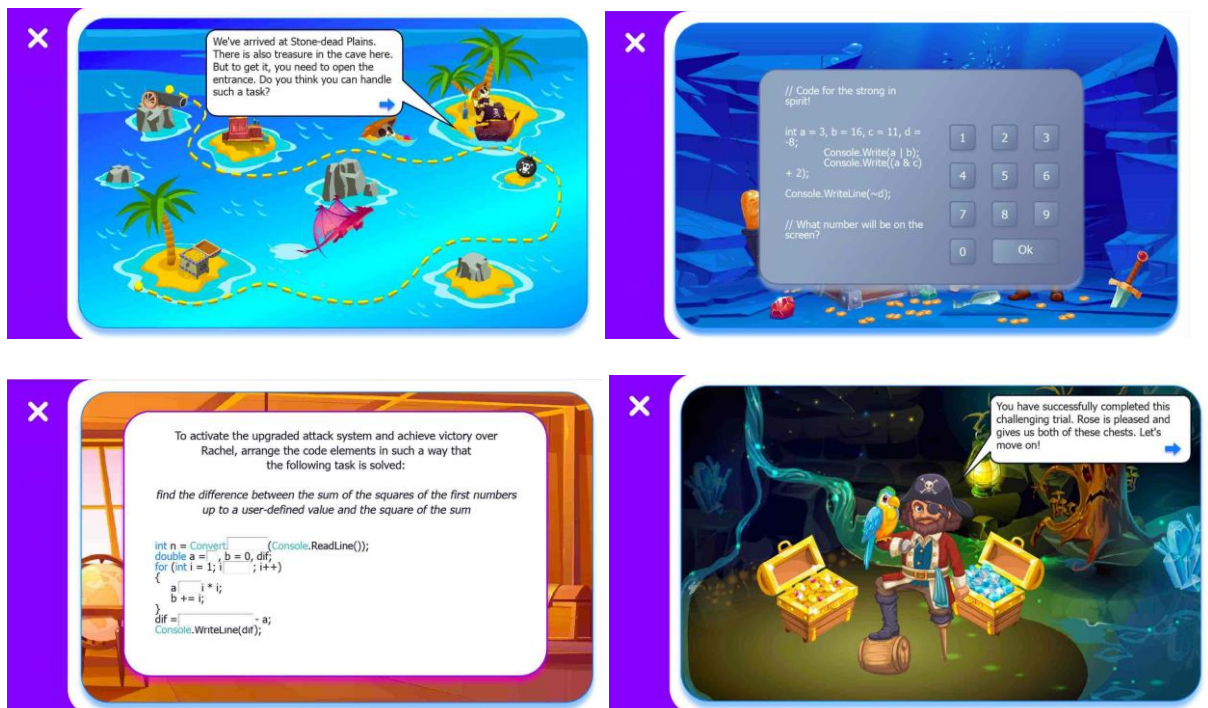


Fig. 9. Adventure game "Mystery Land" as an element of the multimedia educational complex "C#. Quick Learning" (student Filipchuk Anastasiia)

9) an example of a strategy game, the goal of which is teaching the players to think strategically on the basis of the establishment of an optimal survival strategy in a mobile game, is provided in Fig. 10:

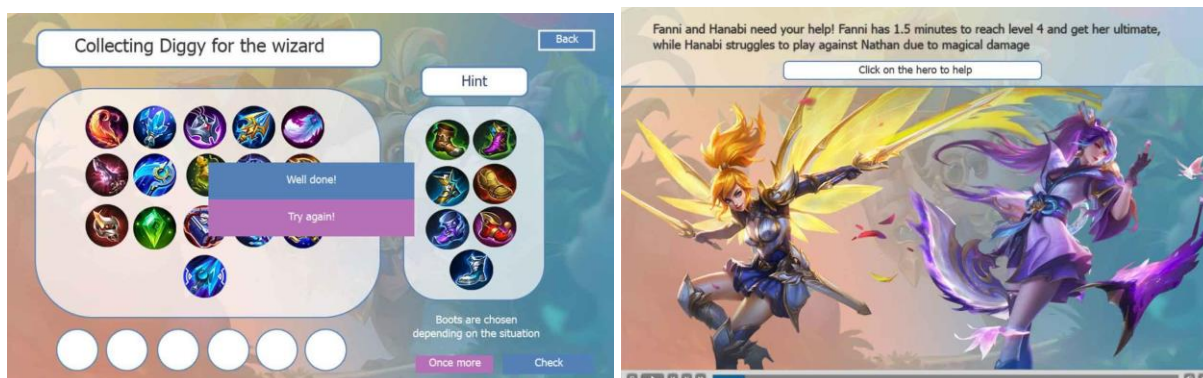


Fig. 10. Survival strategy game as the element of the *How to Survive in Mobile Legends: Bang Bank MER* (student *Kozyrenko Taisiia*)

10) a creative game in which users may either reproduce an image or create their own with the selected colour is provided in Fig. 11:

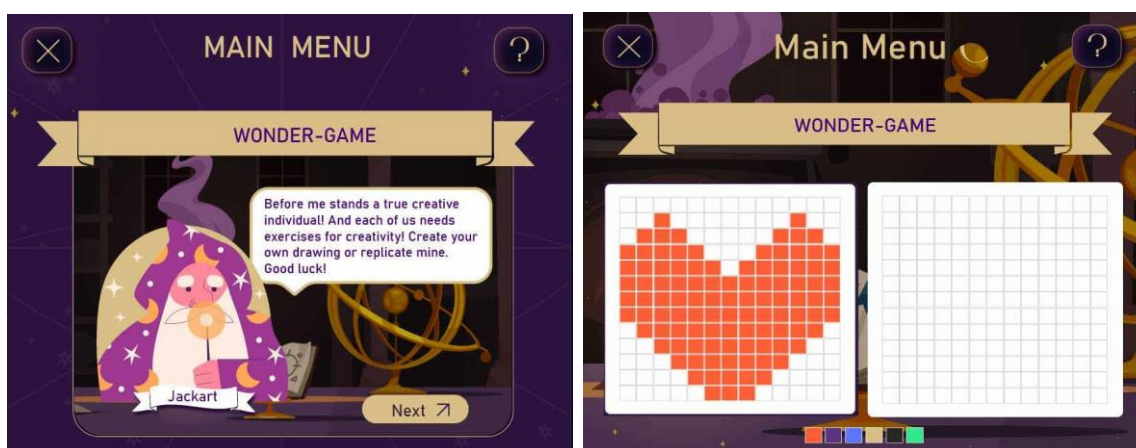


Fig. 11. *Wonder Game* creative game as the element of the *Design Collecting Box of a Student MER* (student *Honcharenko Valeriia*)

11) an example of a dialogue communication game, in which users have an opportunity to communicate with a virtual friend on the issues of correct succulent care, is provided in Fig. 12. The scenario of questions and possible answers is developed, and branching according to the selected response trajectory is implemented in the game:

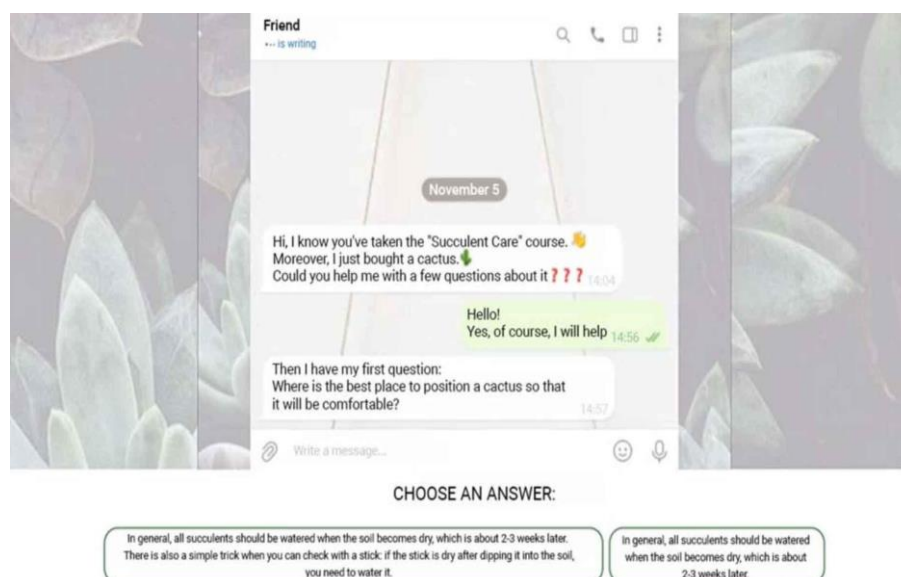


Fig. 12. Dialogue communication game as the element of the Succulent Care multimedia training course (student Zhytlova Iryna) [31]

12) an example of a game in the form of a virtual synthesizer simulator provided in Fig. 13 allows consolidating the skills of playing certain piano tunes. For this purpose, it is at first played within the framework of a specifically recorded video lesson, and then users should reproduce it correctly using the virtual synthesizer simulator:



Fig. 13. Keyboard Simulator as the element of the Self-Instruction Manual of Playing the Piano multimedia resource (student Bondar Anastasiia)

It should be noted that as a result of the performed experiment, all types of DTGs have not only been covered but implemented on a practical level and in a high-quality manner by the students as well. Some MERs containing DTGs have been introduced to the educational process in terms of various subjects. Thus, the MERs for the purpose of studying fundamentals of C# (for the Programming Multimedia Tools subject), special features of colour studies (for the Colour Theory subject), etc., have been implemented. This has supported the improvement of perception and understanding of complicated moments by the bachelors while studying the subject material as a result of games being included in MERs.

As an example, let us describe the experience of 2th-year students specializing in "Publishing and Printing" using the multimedia educational complex "C#. Quick Learning". The complex was developed to simplify the perception and understanding of complex aspects of programming in the C# language. It is used during the course "Programming Multimedia Tools". The structural and content composition of the complex includes three digital

educational games: two detective games and one adventure game, with separate windows of the latter shown in Fig. 9.

The games make it possible, within various storylines, to clearly and accessibly demonstrate how to work with logical operations, how operation priority affects the result, assist in solving programming tasks, and more.

A survey of 45 students (the article analyzed only the section of the Google form related to the use of gaming elements) showed that 94% of students noted a significant increase in motivation to learn programming due to engaging game locations that encourage progress through the educational material. According to 96% of respondents, visualized representation of complex programming concepts in C# through game characters' actions, hints, and tips makes learning easy and understandable.

The survey included a field for students to provide comments and suggestions. Here are a few examples:

"Increase the number of games in the complex so that each topic includes at least one educational game or even several games",

"In the game Mystery Land, in the dragon cave location, you could add interactive tasks, such as opening a secret passage by correctly arranging an array of objects",

"I really liked that each location in the adventure game features different types of tasks. It was very engaging to reach the finale while calculating and programming something",

"I'd love to see more detective-themed games",

"Determining the content of the password as the value of a linear expression was interesting. I got it right on the second try, and now I won't get confused!",

"I'd gladly interact with artificial intelligence during programming lessons".

The above demonstrates positive student feedback on the use of games in learning programming with C#. This provides an opportunity to identify further directions for developing the functionality of multimedia educational resources with gaming elements.

Implementation of the results of MER development experiments in the educational process and their approbation within the framework of the subject has provided an opportunity to create a range of scientific publications co-authored by the students. Among the most interesting ones are the chapter of the collective monograph dedicated to the development of the Colour Theory MER [3] and the scientific article dedicated to the development of a multimedia training course for self-development of users in terms of succulent care [31] should be noted.

It should be noted that many of the MERs developed by the students have become public domain, links to them having been published in the personal system of the Technologies of Electronic Publishing subjects. This has supported the activation of self-education of self-development of the students who would like to widen their scope and learn not only the knowledge from their professional area but, for instance, master playing the piano, learn how to correctly take care of plants, master the art of cooking and more.

5. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

Within the framework of the article, the fundamental analysis of the modern condition of the application of digital training/educational games during the process of studies of school/university students has been performed. The importance of implementation of digital training games in the structure of MERs as elements supporting activation and support of the process of consolidation of knowledge by using them with good effect in the game form has been demonstrated. It has been justified that DTGs should be fully-featured components of MERs. Their implementation in the form of external modules/independent game

programs/games introduced to other platforms violates the integrity of the unified electronic educational space of MERs.

Educational and developmental functions of DTGs that they should activate and develop in terms of MER users have been defined. The basic sequence of steps that may be used as a basis for the creation of DTGs as components of MERs has been provided. Types of DTGs have been defined. The experiment with the involvement of 4th-year students specializing in Publishing and Printing of Simon Kuznets Kharkiv National University of Economics has been conducted to appraise the suggested types of DTGs. To do so, an established all-around semester task in the Technologies of Electronic Publishing subject has been developed, the purpose of which has been the development of MERs containing DTGs. The acquired results have allowed making sure that all the suggested types of games have had practical implementation in the MERs developed by the students. Therefore, the suggested types of DTGs are practicable, and including them in MERs is reasonable.

Within the framework of the article, each type of DTG has been illustrated with author-developed student examples of their implementation within the framework of MERs of different profiles developed by them.

The article describes the experience of using a multimedia educational complex with three games of different genres as part of the course Programming Multimedia Tools. Based on the analysis of feedback from second-year students, it was concluded that the gaming elements of the complex make the learning process more engaging (due to detective and adventure storylines), increase motivation to master the art of programming (thanks to multiple interactive tasks in various game locations), and simplify students' understanding of complex aspects of C# syntax and program construction (through simple game visualization).

In the future, it is planned to develop a classification of the DTGs mentioned in the article, study the issue of improving the efficiency of developing dialogue-based games using AI, and explore the factors influencing the quality of DTG development for handicapped users.

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ЦИФРОВІ НАВЧАЛЬНІ ІГРИ ЯК СКЛАДНИКИ МУЛЬТИМЕДІЙНИХ НАВЧАЛЬНИХ РЕСУРСІВ

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Анотація. У статті визначено важливість реалізації цифрових навчальних ігор у складі мультимедійних навчальних ресурсів. Зазначено, що навчальні ігри сприяють активізації засвоєння навчального матеріалу користувачем за допомогою його подання в ігровій формі. Він має змогу закріпити навчальний матеріал, беручи участь у цифровій навчальній грі. Такі ігри повинні бути складником цілісного мультимедійного навчального ресурсу, який може бути реалізовано у вигляді мультимедійного комплексу, інтерактивного курсу з багатокомпонентним складом, що містить мультимедійний посібник, навчальні відеосимуляції, інтерактивні завдання, підказки та поради, інтерактивні тести, релаксаційні елементи тощо. Отже, цифрова навчальна гра розглядається як невід’ємний структурно-змістовий елемент мультимедійного навчального ресурсу. У статті визначено склад навчально-розвиткових функцій ігор. Обґрунтовано доцільність розроблення та розміщення в ресурсі інструкції до цифрової навчальної гри та наведено послідовність кроків, що може бути використано для розроблення гри. Запропоновані різновиди навчальних ігор, які доцільно реалізовувати в мультимедійному навчальному ресурсі. З метою апробації запропонованих різновидів ігор було проведено експеримент у вигляді сформованого наскрізного семестрового завдання за навчальною дисципліною «Технології електронного видавництва» з розробки мультимедійних навчальних ресурсів, що містять цифрові навчальні ігри, із залученням здобувачів 4 курсу спеціальності «Видавництво та поліграфія». Результат надав можливість пересвідчитися, що всі різновиди ігор мали практичну реалізацію в розроблених здобувачами мультимедійних навчальних ресурсах різного предметного спрямування (як для опанування складних моментів навчальних дисциплін, так і для активізації свого саморозвитку та самонавчання за різними сферами життєдіяльності). У статті кожен різновид ігор проілюстровано авторськими прикладами їх реалізації здобувачами. Матеріал даної статті може розглядатися як джерело інформації для розробників мультимедійних навчальних ресурсів з ігровими елементами.

Ключові слова: мультимедійний навчальний ресурс; цифрові навчальні ігри; навчально-розвиткові функції; базова послідовність кроків; різновиди ігор.

