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*The object of this study is the composition, content, and features of analytical and applied tasks that must be solved in the process of creating a multimedia training course for user self-development. In the context of this work, the problem of the lack of a clear definition of the content-element composition of analytical and applied tasks, which must be solved during the creation of such a course, was solved.*

*An analysis of research into various aspects of the creation of multimedia publications, complexes, courses for self-education and self-development of users in various fields is provided. The systematization and determination of the content and features of analytical and applied tasks were carried out, which should be resolved during the development of the course. Keyword research is based on the analysis of user searches. As a result, "succulent species" (1–10k/month) and "breeding succulents" (100–1k/month) were added as course topics. In order to identify positive practices and bring them to the course, the functionality of analogs was investigated. The development of the technical task makes it possible to determine the elemental and content composition, structural and technological aspects of the course. The choice of the most appropriate software environment for the development of a multimedia educational course was substantiated (through the prism of the analysis of the functionality required for this purpose). An appropriate stylistic direction for the implementation of the design of the course interface has been determined. Page prototypes were created. The implementation of the course and its interactive components (advice, exercises, tests, games) was carried out in the selected Adobe Captivate environment.*

*The solution of each task is illustrated by an example. To demonstrate the creation of a multimedia course, self-development of the user in matters of caring for succulents was chosen. The developed publication is used in the educational discipline "Technologies of electronic publishing" as an illustrative example of creating a course*

*Keywords: multimedia training course, search queries, technical task, succulents, Adobe Captivate*

# DEVELOPMENT OF A MULTIMEDIA TRAINING COURSE FOR USER SELF-DEVELOPMENT

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## 1. Introduction

The intensive development of multimedia technologies produces new requirements for the structure, visual appearance, functionality, and interactivity of modern electronic resources aimed at supporting the education of users [1], activating their self-development and self-improvement in certain issues and areas [2]. It can be both professional self-development and personal development. Both directions are characterized by the user's acquisition of competencies through active thinking and creative problem solving in a specific subject area using modern multimedia technologies. Powerful representatives of multimedia learning technologies include multimedia educational complexes and courses with interactive elements that include various media content (text, pictures, video lessons, audio tips, tests, games, etc.). They provide an opportunity for the user to study and self-develop at a convenient time according to his/her own learning trajectory, taking into account his/her interests, needs, capabilities, and level of preparation [3].

It is worth noting that a person throughout his/her life is in the process of mastering new things from various subject areas that surround him/her and interest him/her. Even

learning how to do culinary arts, sports exercises, meditation, how to use artificial intelligence, take care of animals, plants, etc. are all surrounding subject areas. For all these areas, it will be relevant to create appropriate multimedia training courses (MTCs) for self-development and self-improvement of users. The purpose of such courses will be to help a person acquire new knowledge that is interesting to him/her, acquire new knowledge, skills, and develop new competencies in a certain subject area. However, the process of building such MTCs for the self-development of users is quite difficult to implement and requires working out many issues, many of which are of a weakly formalized nature. Such issues include, for example, the issue of clarifying and expanding the content of MTC, outlined by the customer in the brief, by conducting an analytical study of keywords by subject area. Disclosure of the content-element composition of the technical task for the creation of a multimedia course project is one of the key issues that determines the entire process of MTC development. Justification of the process of choosing a software development environment for MTCs with the necessary functionality is a rather difficult issue, given that the selection criteria are qualitative with an unknown degree of implementation of each functional feature

in software development environments. A separate issue to which it is advisable to pay attention is the determination of the most appropriate stylistic direction of design, in which it is appropriate to implement the MTC interface.

A clear definition of the sequence of the task-solving process from the initial contact with the customer to the drafting of the technical task and the practical creation of the course will allow using the material of this study as a theoretical and methodological basis. It provides an opportunity to determine the composition, content, and features of analytical and applied tasks, which must be solved when developing an MTC for the user's self-development in a certain field.

The specified aspects testify to the timeliness and relevance of working out a scientific topic regarding the development of a multimedia training course for user self-development. The study of this scientific topic will provide an opportunity to build multimedia educational courses with a multi-component content-element composition to activate and support the user's self-development through self-learning.

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## 2. Literature review and problem statement

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Paper [4] provides an opportunity to review multimedia systems in education, to determine their main elements, types, characteristics, and key principles that must be followed during their creation. However, the question of the composition and content of the tasks that must be implemented for the practical reproduction of the multimedia system remains open.

In work [5] it is proposed to investigate the issue of electronic learning from the point of view of the implementation of pedagogical design of teaching aids using multimedia technologies. However, the presented multimedia instructions do not provide a practical recommendation for making a decision regarding the choice of an appropriate stylistic direction of interface design for a multimedia publication of an educational direction in a certain subject area.

In study [6], attention is paid to the issue of choosing a model that should be used as a basis for the construction and meaningful filling of educational projects. The approach based on the implementation of the idea of the Roadmap model is interesting from the point of view of its application within the framework of this study for the formation of a structural scheme indicating the transitions between elements. This will make it possible to structure the information in the technical task and provide the possibility for the user to build a path for mastering the MTC material.

In work [7], a modular-component structure of a virtual learning environment was proposed to support and activate student-centered learning with a meaningful description of the composition of each of its components. However, the structure has a clear link (in components and their elemental composition) to the subject area of the "Publishing and printing" specialty. However, individual recommendations of component 6 "Emulation and simulation of objects and processes", aimed at supporting training, should be implemented in MTCs by introducing interactive tasks in video simulations.

Paper [8] contains an approach to the structural and substantive organization of multimedia educational complexes, a description of the components of each of the levels (illustrative-descriptive, reproductive, and creative) presentation of educational content. However, this work does not contain a mechanism for determining content (when working with

an MTC customer) but allows already ready content to be distributed at the proposed levels.

In study [9], a technique is proposed that allows solving the task of determining the most appropriate structural composition of the multimedia educational publication "Theory of Color". The specifics of the development of the multimedia publication "Piano Self-Teacher" are analyzed in work [2]. These methods give an effective result in the form of a clear list of appropriate structural elements, practically reproduced in real multimedia resources. However, the solution of such a research task as a separate one is expedient only in the case when the customer did not provide any proposals regarding the elemental composition of the publication at the stage of forming the brief and it is necessary to determine them and select the most appropriate ones for implementation. However, the idea embedded in the research data is interesting from the point of view of development. It can be implemented in a complete chain of MTC development tasks to specify the structural and substantive wishes of the customer from the standpoint of analyzing search queries by keywords.

In work [10], the authors developed the subject technology of the design of multimedia publications. The model made it possible to determine quality criteria for evaluating multimedia publications, but it did not contain practical advice on choosing an appropriate software environment for the process of creating such multimedia publications that meet the outlined criteria.

In study [11], instructions were created for multimedia developers and users of e-learning. These are valuable results of research on how people learn online, how this process can be influenced in order to improve its quality. However, they are more general approaches to what to consider when creating digital learning resources. They do not contain recommendations for the formation of an appropriate structural and content of publications based on the analysis and processing of the results of search queries. They do not consider the process of choosing an appropriate means of developing MTCs of a certain direction. No attention was paid to the formation of the design solution of the publication interface, which is a certain "digital face" of the MTC.

In work [12] attention is focused on the importance of preparing multimedia content of various types for inclusion in publications based on the application of knowledge about color, image compression methods, video preparation, etc. However, within the scope of this study, no recommendations are offered for choosing an appropriate MTC interface design style, and the video is not considered from the point of view of creating active simulations with an interactive task in order to provide the user with the opportunity to learn based on the performance of tasks in the video lesson.

Study [13] contains approaches to gathering media content into integrity. It presents work with attributes (based on the use of the Petri network model, Hoare logic, Simple Interactive Multimedia Model, etc.) in order to create a high-quality multimedia author's product. However, the work does not consider the issue of which media content is expediently included in the publication for self-development at the expense of the user's self-education.

A description of the functions, structure, and features of the development of an online assistant is given in [14]. However, this research is strictly related to the subject area of the assistant and is oriented, more, to the development of a mobile application.

Study [15] provides an answer to the question of how to properly approach the development of electronic educational resources in the form of an electronic manual. However, during the disclosure of the issue of the technology of creating an electronic educational manual, the formation of the components of the technical task and the decision to choose an appropriate software environment for the development of the electronic manual were not covered.

The idea of researching the functionality of software tools needed for the practical implementation of an educational animation publication, laid down in work [16], is interesting from the standpoint of development for the subject area of “user self-development using the capabilities of MTCs.” It was laid down and developed during the implementation of the task of making a decision on choosing the most appropriate software environment for the development of MTC.

However, the authors of the above scientific works [4–16] did not fully cover the content and interaction between the tasks that must be solved in the process of creating multimedia educational publications (courses/complexes). Thus:

1) attention is not focused on the importance of analyzing user requests by keyword of the subject area, as a separate task for forming the content-elemental composition of the MTC, based on the needs of the target audience;

2) details of the components of the technical task (structural, technological, etc.) for the creation of an MTC for self-development through self-study are not given;

3) the necessary attention is not paid to the issue of substantiating the choice of an appropriate MTC development environment to reproduce the required functionality of the course;

4) the issue of determining the most appropriate stylistic design direction for visualizing the MTC interface and its components is not covered.

Therefore, many questions remained open, which indicates the expediency of their disclosure on the example of the implementation of MTC for the self-development of the user. As a subject area for demonstrating the process of solving the tasks of MTC development, the field of self-development of the user in the care of house plants was chosen, namely, self-education of users in the Caring for succulents.

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### 3. The aim and objectives of the study

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The purpose of our study is to develop a multimedia training course for user self-development. This will provide an opportunity to increase the degree of validity of decision-making regarding the definition of the list of topics that should be included in the course and practically develop a multimedia course “Caring for succulents” in a certain design style.

To achieve the goal, the following tasks were set:

– to analyze the requests of the target audience and determine the list of topics for inclusion in MTC;

– to conduct a comparative analysis of analogs of the developed MTC;

– to detail the components of the technical task and determine the most appropriate software development environment;

– to determine the most appropriate stylistic direction of the interface design and to implement MTC “Caring for succulents”.

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### 4. The study materials and methods

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The object of our research is the composition, content, and features of analytical and applied tasks that must be solved in the process of developing MTC for the user's self-development.

Research hypothesis: the implementation of analytical and applied tasks of the process of development of MTC for self-development in a defined cause-and-effect sequence with all outlined components will increase the degree of correspondence of content and element content of MTC. It will also ensure the effectiveness of the user's self-development in matters of caring for succulents with the help of comprehensive representation of information, use of media content of various types, training based on interactive tasks, games, and tests.

The research is based on the use of such methods as:

– comparative analysis (to study the existing in theory and practice features of creating multimedia educational publications in the form of courses, complexes; to carry out a comparative analysis of analogs in order to determine positive practices that should be brought to MTC);

– statistical analysis (to determine the quantitative indicators of search results of the target audience by keywords of the subject area, performed with the help of the Google Ads keyword statistics analysis service);

– structural analysis (for detailing the structure of the brief and TT by elements, building structural and technological diagrams);

– the method of analyzing hierarchies (to determine the numerical values of the degree of importance of the pairwise comparison criteria for choosing a software environment for MTC development; to determine the numerical values of the degree of importance of the stylistic directions of the MTC interface design);

– a linguistic approach based on the theory of fuzzy sets and linguistic variables (for formalization in order to bring the qualitative presentation of a criterion to its quantitative evaluation and determine the degree of realization of the criteria according to alternatives of software environments);

– a process approach (for the implementation of applied development of MTCs).

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### 5. Results of research into the process of developing a multimedia training course for user self-development

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#### 5.1. Analysis of the requests of the target audience and determination of the list of topics to be included in the multimedia training course

For the high-quality development of MTC and the holistic representation of the customer's requirements, it is necessary to collect these requirements in a certain primary document (brief). In the brief, the general idea of the course is formed, certain wishes and/or requirements for the structure, content, design, interactive elements that must be reproduced are given. A fragment of the brief for the development of MTC “Caring for succulents” is shown in Fig. 1.

After receiving an initial idea about the planned MTC project, it is necessary to analyze the requests of the target audience and determine the list of topics that should be included in the MTC based on the results of these requests.

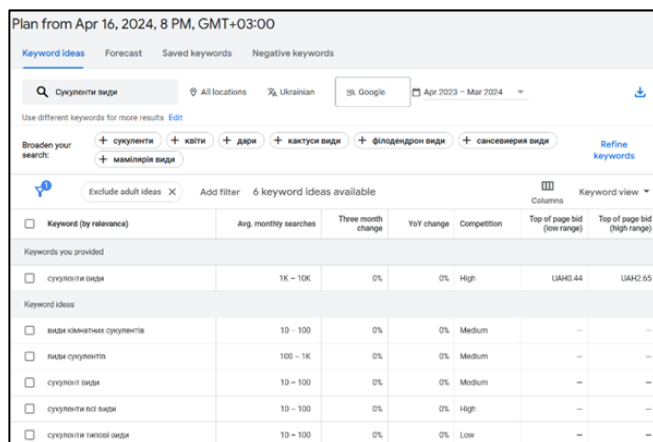
3.INFORMATION ABOUT THE MULTIMEDIA COURSE	
3.1 Title of the publication	How to care for succulents
3.2 Brief description <i>(describe in simple words what the multimedia course will be about)</i>	This publication should contain information on the specifics of caring for succulents. Specifically, how to transplant, water, place, feed, etc. Provide a description of the types of succulents and their features. All this should be presented with many tips, advice (audio guides can be used) and video examples, as well as interactive exercises and video tutorials for the user to complete during the learning process. The presentation should be in natural colors (preferably green and white). It is important that the publication contains a training game so that the user can take a test after learning (images of different types of succulents should be used in a wider number of questions). Of course, there should be a description of basic terminology
3.3 Purpose of creation	Teaching beginners basic knowledge in the sphere of succulent care, their development in this matter
...	...
3.6 The intended structure	Registration box Screensaver Main menu Sections with information about caring for succulents Thematic glossary Game block Test your knowledge Information on the publication Information about the author
...	...

Fig. 1. A fragment of the brief for the creation of a multimedia educational course “Caring for succulents”

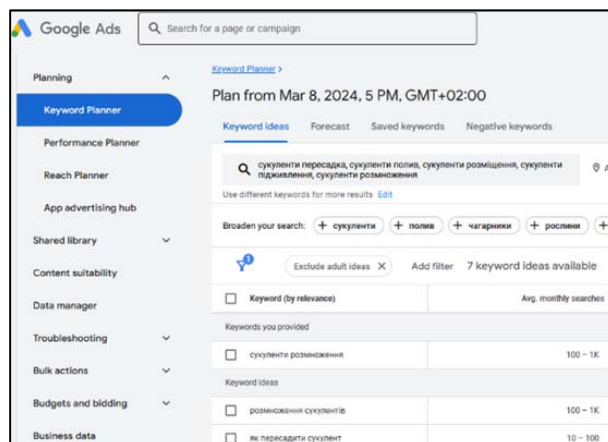
Performing this task makes it possible to determine exactly what information users are looking for, how often they are looking for it, etc. If there are stable words and phrases that are often used by users, this can serve as a basis for introducing new sections/topics of a certain direction into the composition of MTC. A similar analysis was performed using the Google Ads keyword statistics analysis service [17], which provides an opportunity to determine quantitative indicators of the results of search queries of the target audience

by keywords of the subject area. Fig.2 shows an example fragment of the conducted analysis.

Thus, the number of requests for the phrase “succulent species” is from 1 to 10 thousand/month, which indicates the feasibility of describing species in MNK. Analysis of the number of requests for the phrase “breeding succulents” from 100 to 1 thousand/month indicates the feasibility of implementing this topic as part of a multimedia course manual.



a



b

Fig. 2. An example-fragment of keyword analysis (monthly) by subject area: a – the number of requests for the keyword “succulent species”; b – the number of requests for the keyword “breeding succulents”

**5. 2. Comparative analysis of analogs of the developed multimedia training course**

Comparative analysis of analogs allows for the following:

1) to make sure that there will not be a situation of creating a course that already exists with all the necessary functionalities;

2) to study the functionality of analogs, to identify their strengths, which should be introduced and implemented in the new course, and to identify weaknesses that should be avoided in the new MTC.

In the process of analyzing analogs, it is necessary to proceed from certain criteria, such as answers to questions about the structure of the publication, design, interactive components, etc. Such criteria can include: structuredness; readability; the quality of the design solution (whether the design style is chosen appropriately, the color scheme, fonts, etc. are selected). Also, it is appropriate to analyze the comprehensibility, accessibility, and convenience of the location of navigation and control elements; availability of audio support in the form of audio tips, audio hints, audio explanations, thematic galleries with images, etc. It is necessary to pay attention to the availability and degree of implementation of interactivity and what exactly supports it. This means whether there are interactive tasks and exercises, educational video lessons with the possibility of engaging the user in interactive interaction, relaxation themed games, such as educational games, crosswords, puzzles, etc. The analysis of the presence of a creative component deserves special attention (for example, a built-in editor so that you can feel like a designer, artist, gardener, chemist, astronomer, etc.). An important criterion is the presence and diversity of the types of test questions involved (multiple, comparison, ordering, etc.) and the logic of the tests. It is necessary to pay attention to how the questions are presented: embedded in the pages of the multimedia edition, individually after the corresponding pages, in a test block after a certain topic, as an end-to-end generalization test for several/all topics. Of course, as criteria to be analyzed, the

presence of a feedback system, adaptability, level of content protection, etc. The elemental composition of the criteria can be modified and supplemented with own criteria for evaluating the quality of analogs in accordance with the specifics of the subject area of the publication/course and the customer's requirements.

An example-fragment of the implementation of the analysis of analogs of electronic network resources by the subject area of Caring for succulents is given in Table 1. The scale of the degree of implementation of the criterion from 0 to 1 was used for the analysis (0 – no implementation, 0.5 – medium degree, 1 – high degree of implementation).

Results of the analysis by criteria determine whether there is a need to create a new MTC and what exactly needs to be implemented in it in order to be more competitive and in demand by the target audience of users than existing analogs. According to the considered example of the analysis (Table 1), none of the analogs scored the maximum number of points, which indicates the feasibility of developing a new MTC with maximum compliance with the criteria. From the fact that the existing analogs are not implemented or not fully implemented, certain requirements can be formed regarding the inclusion of new functionality in the course and topics requested by users (selected based on the results of the analysis of search queries).

So, it is advisable to include topics related to the types of succulents and the process of their reproduction to the course on self-development of the user in the matter of caring for succulents. As elements of MTC, it is advisable to implement interactive tips, educational video lessons, an interactive relaxation game, etc. For example, an educational video lesson can contain an interactive task, the solution of which will help the user to transplant a succulent in the correct sequence.

The content of the brief, the results of the analysis of the requests of the target audience, and the functionality of analogs are input information for the formation of the components of the technical task.

Table 1

Fragment of the analysis of analogs in the category “electronic network resources”

Criterion	Analog	Analog 1 (proper care of cacti and succulents [18])	Analog 2 (care for succulents with Yaros [19])	...	Analog 8 (Planet Dese [20])
Clarity of the structure		1	1	...	0.5
Availability of the theme «succulent species»		0.5	0.5	...	0.5
The presence of the topic «succulent reproduction»		1	0.5	...	0.5
...		...	...	...	...
Design quality		1	0.5	...	1
Availability of tasks/exercises		0.5	0	...	0
Availability of interactive advice		0	0	...	0.5
Availability of video lessons		0.5	0.5	...	0
Availability of educational interactive games		0	0	...	0
The presence of interactive objects on the pages		0.5	0.5	...	1
...		...	...	...	...
Total points:		8	6	...	7
The maximum possible number of points:		11			

### 5.3. Detailing the components of the technical task and determining the most appropriate software development environment

The input information for the formation of the technical task (TT) is information according to the brief, the results of processing user requests, the functionality of existing analogs.

The information in the brief provides the vision, wishes, and requirements of the customer. The results of processing user requests determine which sections/topics it is advisable to expand in the structural and content composition of MTC. The defined functionality of existing analogs, which is in demand from the point of view of users, should be considered as interesting functionality that should be implemented in the MTC implementation.

TT contains specified and clearly formulated components and characteristics of the multimedia course project. The approach presented in work [21] by the co-author of the current paper to the structuring of the representation of information in TT for the development of a multimedia educational complex can also be used during the formation of TT components for the development of MTC for user self-development. In general, TT covers the following components: idea, goal, task, characteristics of the target audience (portrait of the target user), existing limitations (technical, technological, economic, psychological, etc.) and assumptions for the future project of MTC. Also, the TT outlines a number of requirements (for the interface, stylistic design of MTC and its elements, graphic design, and font design, viewing tools). It contains a description of content and sources. That is, a description of the contents of the content with an indication of the official sources from which the content will be taken and relevant agreements. A description of the content that will be taken from open resources with content for free use, indicating which content will be taken from which resource. Definition of the author's content, which will be specially developed for this publication and provided by the customer. Also, the TT contains a description of the types of media content (that is, what exactly and in what format should be submitted as text, pictures, video, audio, etc.). As part of the TT, it is also specified how the preparation, editing, layout and adjustment of content, page layout, etc. will be carried out. It contains a structural diagram, a project specification, a technological diagram, etc.

Thus, the structural scheme reflects the logic of the relationship between individual structural elements of the MTC being developed. However, the process of forming a structural scheme has a certain ramification, according to the input information received in the TT. There may be a situation when the customer already has an offer regarding the desired elements of the structure (Fig. 1). And additionally, based on the results of the keyword research (Fig. 2), the expediency of expanding the structural content of MTCs with certain topics was determined. So, topics related to species and breeding succulents have been added. In this case, you can start building a structural diagram (Fig. 3).

However, the opposite situation may also occur, when no proposals regarding structural elements were provided by the customer during the development of technical specifications. Then there is a need for an in-depth analysis of keywords by subject area to outline the range of potential structural

elements and conduct additional research to determine the most appropriate of them for implementation. For example, in works [2, 9] appropriate methods are proposed, with the help of which, with the use of economic-mathematical tools, it is possible to determine appropriate structural elements for a multimedia publication.

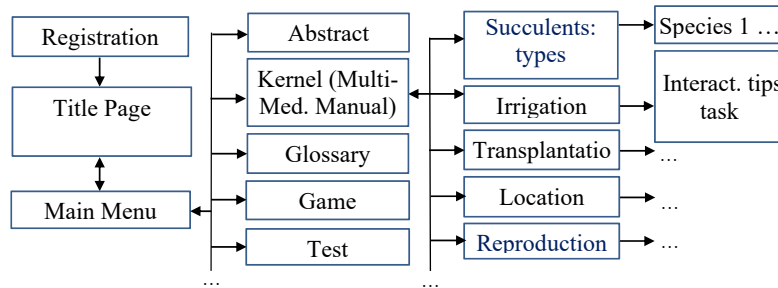


Fig. 3. Fragment of the block diagram of the multimedia training course “Caring for succulents”

Having a clear definition of structural elements and transitions between them, the specification for the project is developed. The specification must contain a description of the element composition of each page, namely: specifying the page, its elements, the functionality of each element (for example, “go to ...”, “start the game”, etc.), a description of the properties of each element and the operation of scripts, if they are provided. At this stage, it is most often a verbal description, which later – during the development of design (sketches, page prototypes), takes a visualized form. Most often, this document is represented in the form of a table to clearly identify the components of each page of the multimedia course.

After that, a description of the composition of the project works is carried out with an indication of the terms of their implementation and the definition and outline of the resource composition of the project, namely: information resources, technological conditions, involved specialists, hardware, and software, which is planned to be used during the implementation of each technological operation to carry out the creation of MTC.

Built on the basis of this information, the technological scheme shows a complete chain of technological operations, represented in a cause-and-effect sequence, and the corresponding resources that must be used to perform each of the operations. At this stage, it is important to make a decision on the choice of software development environment for the MTC, which should be noted in the technological scheme.

The approach to software selection presented in [16] was the basis and developed to implement the task of choosing the most appropriate software environment for MTC development. In the framework of this study, it was proposed to expand and unify term-sets based on the introduction of a variable with the value “0” into the basic set. This has made it possible to eliminate redundancy during the calculation of the weighted score and the utility function due to the exclusion from consideration of the criteria, the implementation of which is not provided for in the alternatives.

Therefore, in order to increase the degree of reasonableness of the decision-making process regarding the choice of a certain tool for the development of MTC, the following sequence of steps is proposed within the framework of this study:

– step 1: formation of the base of selection criteria. As criteria for  $W_i$ , at  $i = \overline{1, n}$ , the following are proposed: the possibility of implementing different pedagogical trajectories in the project ( $w_1$ ), the presence of interactive objects ( $w_2$ ), the possibility of working with a timeline ( $w_3$ ), the possibility of defining different states for elements ( $w_4$ ), a set of templates for interface elements ( $w_5$ ), availability of different modes for creating video simulations ( $w_6$ ), availability of different types of interactive test questions ( $w_7$ ), availability of integration of points received for various tasks ( $w_8$ ), possibility of writing scripts ( $w_9$ ), generation of course completion certificate ( $w_{10}$ ), the ability to preview the project ( $w_{11}$ ), saving in html ( $w_{12}$ ). The criterion base is open to modification and expansion, according to the specifics of the construction of a certain MTC and the functionality required for this;

– step 2: formalization of the criteria description. To evaluate criteria that have a qualitative nature of representation, it is suggested to use the theory of fuzzy sets and linguistic variable. This will provide an opportunity to move from a qualitative to a quantitative representation of  $W_i$ , allowing us to explore the degree of realization of each criterion within the framework of an alternative software development tool. Each criterion is represented in the following formalized form:

$$\langle w_i [M_i^r (BMN_i^k), \mu_i(w_i)] \rangle, \tag{1}$$

where  $w_i$  is the name of the criterion;

$M_i^r$  is the term-set, at  $r \in \overline{1, 4}$ ;

$BMN_i^k$  is the basic set of variable value determination, at  $k \in \overline{0, 3}$ .

For example, according to the proposed formalization,  $w_6$  will take the following form: <availability of different modes for creating video simulations: [the creation of video simulations in the environment is not provided (0 points), only a mode for passive video simulations is available (1 point), there are modes of passive and active video simulations without fidelity assessment user actions (2 points), available modes of passive and active video simulations with evaluation of the accuracy of user actions (3 points),  $\mu_6(w_6)$ >:

– step 3: determination of criteria weights. The  $W_i$  analysis procedure begins with the construction of the matrix of pairwise comparisons  $\|W_{ij}\|$  (at  $i, j = \overline{1, n}$ ) criteria that are compared with each other using a 9-point scale of relationships [22]. The matrix construction procedure is based on the question: “To what extent is one of the criteria more important than the other when creating an MTC?”. As a result, a matrix of the following form was constructed:

$$W_{ij} = \begin{pmatrix} & w_1 & w_2 & w_3 & \dots & w_{12} \\ w_1 & 1/1 & 3/1 & 4/1 & \dots & 1/3 \\ w_2 & 1/3 & 1/1 & 5/1 & \dots & 4/1 \\ w_3 & 1/4 & 1/5 & 1/1 & \dots & 3/1 \\ \dots & \dots & \dots & \dots & \dots & \dots \\ w_{12} & 3/1 & 1/4 & 1/3 & \dots & 1/1 \end{pmatrix} \tag{2}$$

The calculation of weighting factors is based on the following formula:

$$\mu_i(w_i) = \frac{\sum_{j=1}^m x_{ij}}{\sum_{i=1}^n \sum_{j=1}^m x_{ij}}, \tag{3}$$

where  $\mu_i(w_i)$  is the value of the weighting coefficients of the  $i$ -th criteria;

$x_{ij}$  is an element at the intersection of the  $i$ -th row and the  $j$ -th column of the matrix of pairwise comparisons.

The calculated values of the vector of weight coefficients of criteria  $W_i$  are as follows:  $\mu_1(w_1=0.075)$ ,  $\mu_2(w_2=0.087)$ , ...,  $\mu_6(w_6=0.129)$ , ...,  $\mu_{12}(w_{12}=0.059)$ ;

– step 4: determination of the degree of implementation of the criteria according to alternative development environments. The following are considered as alternative development environments ( $A_s$ , at  $s = \overline{1, p}$ ):  $A_1$  – Adobe Captivate,  $A_2$  – Articulate Storyline 360,  $A_3$  – Teachable. As a result of the study of  $A_s$ , a specific value is determined by the degree of implementation of each  $W_i$  in the form of a corresponding score from the set  $BMN_i^k$ , which corresponds to the state of implementation of  $W_i$  within the framework of the studied  $A_s$ .

An example-fragment of the results of the study of  $A_s$  states by the degree of implementation of each  $W_i$  looks like this:

$$A_1 = \left\{ \begin{matrix} w_{i=1} [M_{i=1}^{r=4} (3)], w_{i=2} [M_{i=2}^{r=4} (3)], \\ w_{i=3} [M_{i=3}^{r=4} (3)], \dots, w_{i=12} [M_{i=12}^{r=4} (3)] \end{matrix} \right\};$$

$$A_2 = \left\{ \begin{matrix} w_{i=1} [M_{i=1}^{r=3} (2)], w_{i=2} [M_{i=2}^{r=4} (3)], \\ w_{i=3} [M_{i=3}^{r=4} (3)], \dots, w_{i=12} [M_{i=12}^{r=4} (3)] \end{matrix} \right\};$$

$$A_3 = \left\{ \begin{matrix} w_{i=1} [M_{i=1}^{r=2} (1)], w_{i=2} [M_{i=2}^{r=3} (2)], \\ w_{i=3} [M_{i=3}^{r=1} (0)], \dots, w_{i=12} [M_{i=12}^{r=4} (3)] \end{matrix} \right\};$$

– step 5: making a decision on choosing the most appropriate  $A_s$ . The weighting coefficients  $\mu_i(w_i)$  determined in the previous steps and the degree of their implementation  $BMN_i^k$  for each  $A_s$  provide an opportunity to calculate the weighted score ( $D$ ) for each  $w_i$  using the formula:

$$D_i(w_i) = \mu_i(w_i) * BMN_i^{k, \forall k \neq 0}. \tag{4}$$

Criteria for which the value of  $k$  from the base set  $BMN_i^k$  is not equal to “0” take part in the calculation, that is, the criterion has a certain degree of implementation (from 1 to 3 points) in the software environment.

Making a decision on choosing the most optimal of  $A_s$  is based on the calculation of the value of the utility function, which shows the result of the choice of  $A_s$  in a specific state for all  $W_i$ :

$$f(A_{s=\overline{1,p}}) = \sum_{i=1}^n D_i(w_i) \rightarrow \max. \tag{5}$$

Our results showed that the best  $A_s$  as an environment for the development of MTC is  $A_1$ , i.e. Adobe Captivate, with  $f(A_1) = 3.26$ .

A fragment of the technological scheme with an indication of the selected software development tool for the creation of MTC “Caring for succulents” is shown in Fig. 4.

At the end of work with TT, the cost of MTC project development is calculated. Alternative cost options are given, taking into account variable elements in the technological chain, and a decision is made about the feasibility of carrying out the development according to the above requirements and elemental composition. If necessary, the requirements, structure, composition, resources used, etc. are modified. to create an MTC (everything is agreed with the customer) [21].

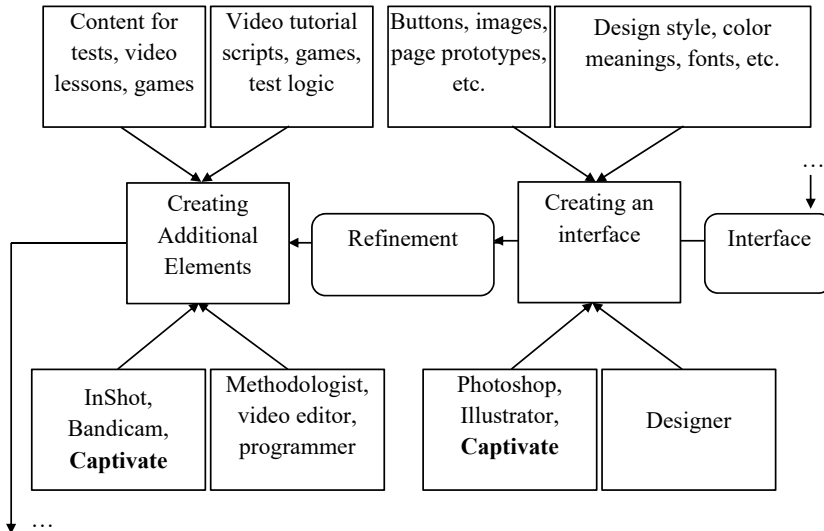


Fig. 4. Fragment of the technological diagram of the process of creating a multimedia training course “Caring for succulents”

**5. 4. Determination of the most appropriate stylistic direction of interface design and implementation of the multimedia training course “Caring for succulents”**

The overall impression of the course depends on its appearance. Simplicity, appropriateness of the topic make the course clear and pleasant for the user. In the process of developing a design solution, it is necessary to determine the most appropriate design style in which the MTC interface will be designed. As alternatives to stylistic directions of design, the following styles  $ST_v$  were considered, at  $v=1, g$ : google material design ( $st_1$ ), retro ( $st_2$ ), skeuomorphism ( $st_3$ ), minimalism ( $st_4$ ), organic & natural ( $st_5$ ), apple-style ( $st_6$ ), flat design ( $st_7$ ), art deco ( $st_8$ ). The list of styles is outlined based on the analysis of their popularity [23].

To determine the numerical values of the degree of importance of a pair of comparative stylistic directions, as alternatives, the method of hierarchy analysis was applied [22]. The decision-maker is an expert in the design of multimedia educational web resources. The expert compared  $ST_v$  with each other using a nine-point relativity scale. The procedure for constructing a matrix of paired comparisons is based on the question: “To what extent is one of the stylistic directions of the design preferable to the other in terms of improving the quality of the visual presentation of the interface of MTC “Caring for succulents”?”.

The weight of each  $ST_v$  is calculated as the sum of the elements of each row divided by the total for all rows. Fur-

ther actions are aimed at ranking  $ST_v$  by weighting factors.

A comparison of stylistic directions of design is given in Table 2.

This approach makes it possible to prioritize stylistic directions for the implementation of MTC interface design. The highest rank=8 (according to the maximum value of the weight) was given to the style “minimalism” ( $st_4$ ), which was chosen as the most appropriate for visualizing the interface of MTC and its components.

After deciding on the choice of a stylistic design direction, it is advisable to proceed to the selection of a color scheme, fonts, to develop prototypes of typical pages. Most often, these are pages: registration, main menu, content, pages of a separate topic, test questions, video lessons, glossary, game, system requirements, source information, information about the author.

Also, it is necessary to determine the composition and location of navigation elements according to the project, the appearance of buttons in different states, etc. If the MTC plans to use a character that will accompany the user, then his/her appearance, picture of emotions and sound accompaniment are developed.

Table 2

Results of comparison of stylistic design directions for the interface

–	$st_1$	$st_2$	$st_3$	$st_4$	$st_5$	$st_6$	$st_7$	$st_8$	Sum in row	Weight	Ranking
$st_1$	1,00	0,25	0,33	3,00	3,00	0,25	2,00	0,25	10,08	0,07	4
$st_2$	4,00	1,00	2,00	0,17	0,25	0,14	0,33	0,17	8,06	0,06	3
$st_3$	3,00	0,50	1,00	0,14	0,33	0,14	0,50	0,14	5,76	0,04	1
$st_4$	0,33	6,00	7,00	1,00	4,00	0,33	8,00	7,00	33,67	0,23	8
$st_5$	0,33	4,00	3,00	0,25	1,00	4,00	7,00	9,00	28,58	0,20	7
$st_6$	4,00	7,00	7,00	3,00	0,25	1,00	3,00	2,00	27,25	0,19	6
$st_7$	0,50	3,00	2,00	0,13	0,14	0,33	1,00	0,17	7,27	0,05	2
$st_8$	4,00	6,00	7,00	0,14	0,11	0,50	6,00	1,00	24,75	0,17	5
Total:									145,43	1,00	–

Tones and shades of green were chosen as the basic colors (Fig. 5), as the bearer of the symbol of life and development. The chosen font for button signatures is Arial (size 16 pt), a readable and familiar font that inspires confidence in the user; for titles and text descriptions on pages – Georgia (size 18 pt).

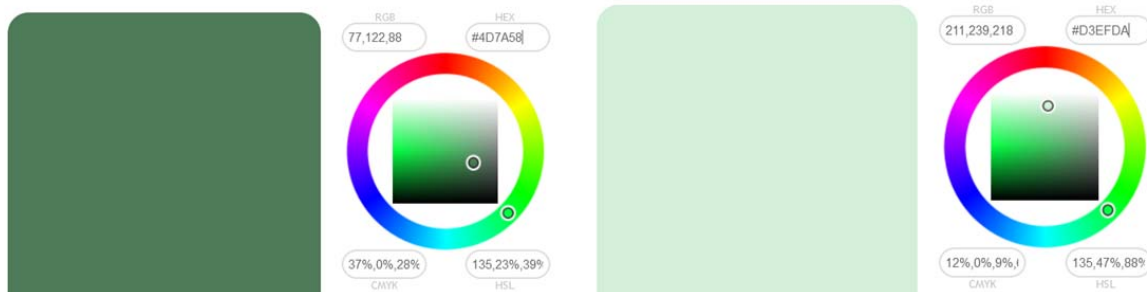


Fig. 5. Example of selected base colors for a multimedia training course



The appearance and change of states of navigation and control elements are given in Table 3. The buttons are created according to the same principle in terms of color, size, and pattern.

In the process of MTC development, layouts and properties of each slide and their elements were created and adjusted, the time of existence of elements on the slides, corresponding transitions, etc. was determined. Examples of some of the settings are shown in Fig. 7.

Table 3 Design and change of states of MTC navigation and control elements

Button before pressing	Button after pressing	Button before pressing	Button after pressing

Table 3

Fig. 8 shows some of the main pages of the developed multimedia course, which included pages of added topics (based on search results) related to species and breeding succulents. The total volume of the course is 74 pages. Buttons and icons were designed using Adobe Captivate, Adobe Photoshop, and Adobe Illustrator.

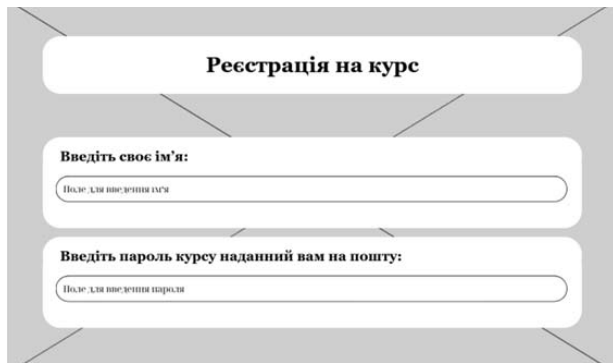
Some of the prototypes of typical pages of MTC “Caring for succulents” are shown in Fig. 6.

MTC “Caring for succulents” provides knowledge about types of succulents and develops skills in transplanting, watering, placing, feeding, and breeding succulents on the basis of a multimedia manual visualized with many examples and tasks. It is the theoretical core of the course.

The development of prototypes provides an opportunity to move to their practical reproduction in a software environment. The practical implementation of the MTC “Caring for succulents” was carried out using the functionality of the software environment Adobe Captivate (released 2023) [24, 25], which was chosen as the most appropriate for the implementation of the MTC.

The interactive component of MTC includes interactive exercises in the form of video lessons, interactive tips, interactive tests by topic, a thematic relaxation component in the form of an educational game. For each topic there is a separate page with interactive objects, which is opened by pressing the “More details” button. Topics include educational video lessons with text explanations.

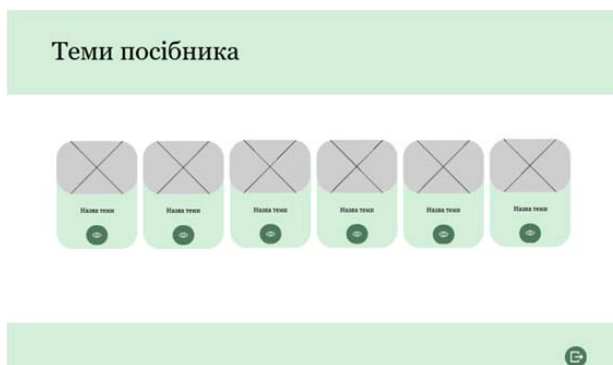
In the topics of transplanting, watering, placement, reproduction, interactive objects are tips, the content of which depends on the user’s actions (Fig. 9).



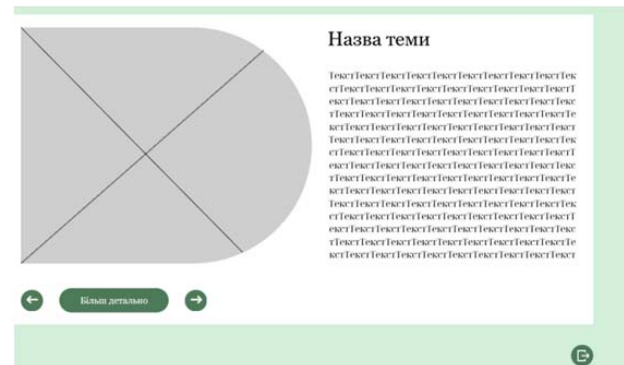
a



b



c



d

Fig. 6. Examples of prototypes of some typical pages of a multimedia training course: a – registration page; b – main menu page; c – content page with topics; d – page of a separate topic



Fig. 7. Examples of settings: *a* – slide layout settings; *b* – slide settings; *c* – header settings; *d* – button settings

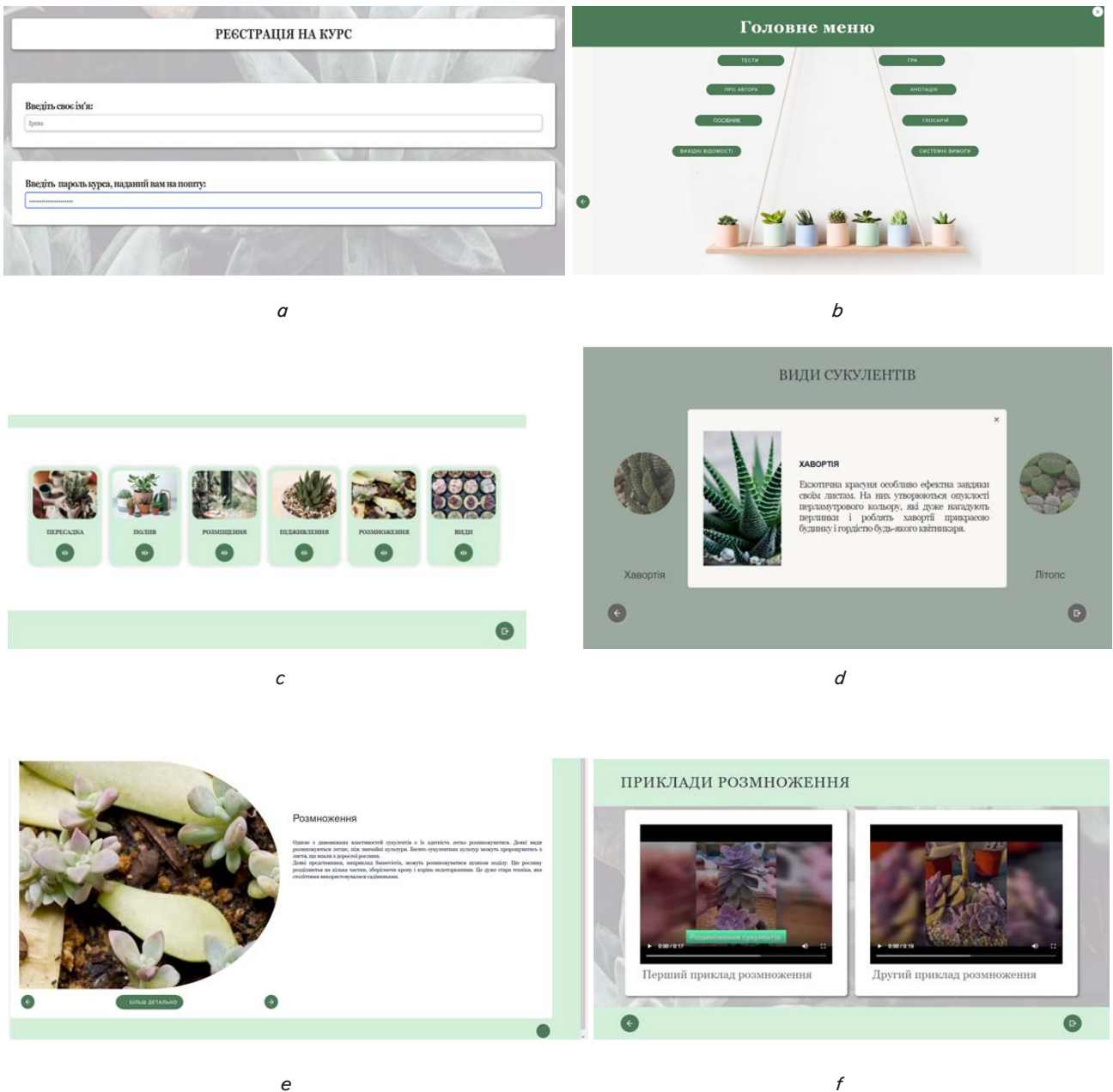


Fig. 8. Pages of the developed multimedia course: *a* – registration page; *b* – main menu page; *c* – page with topics; *d* – page of the topic with types of succulents; *e* – page on the topic of breeding succulents; *f* – page with interactive exercises on the topic of breeding succulents

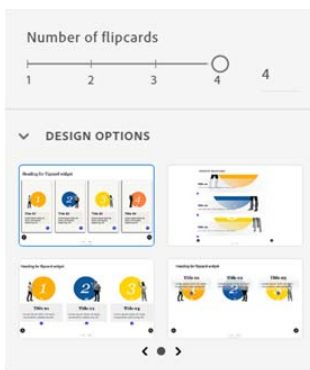


Fig. 9. Example of an interactive tip in the “Placement” topic (the “Can be placed” case): *a* – element settings; *b* – type of advice

The idea of such pages is to show, based on the results of actions performed by the user, how succulents can and cannot be cared for. Another implementation of advice pages is based on the use of interactive flip cards. An example of the settings made, and the final form of interactive cards is shown in Fig. 10.

An important component of the training process is monitoring its effectiveness based on the user passing the test, which

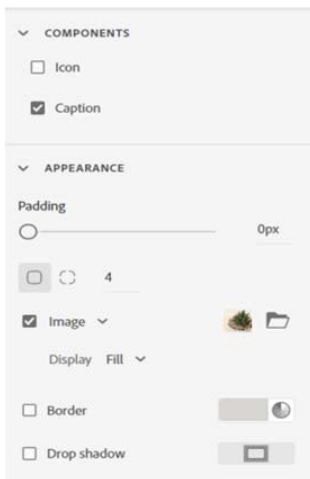
is also an educational component of MTC. Since this course is aimed at the self-development of users, the number of times to pass the test is not limited, and the pedagogical trajectory of working with MTC is laid in such a way that it makes it possible to pass the test, even if the user has not passed a certain topic. This distinguishes MTCs for self-development from those aimed at the mastery of certain academic disciplines with the assignment of points as grades/parts of the discipline.



*a*



*b*



*c*

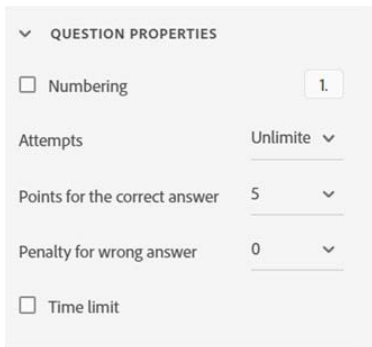


*d*

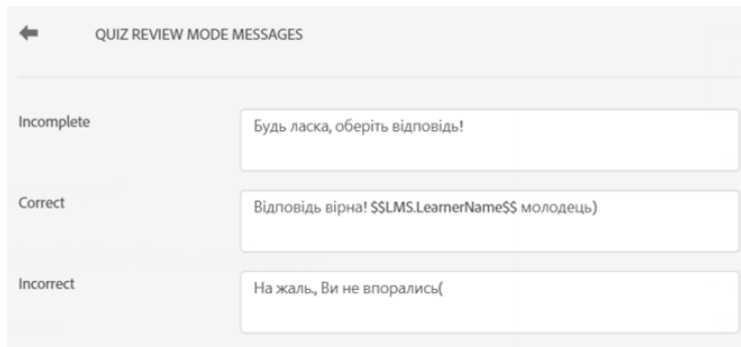
Fig. 10. Example of settings and the type of interactive cards for advice on fertilizers (topic “Fertilization”): *a* – settings of the front side; *b* – front side; *c* – adjustment of the reverse side; *d* – reverse side

During the formation of tests for each topic, its properties were determined, a pool of questions was formed, the appearance and content of each page with questions were determined, and a visualization of the test result was specified. If the user scored 70/100 points, it is considered that s/he passed the test, if less, the user has an unlimited number of attempts to pass the test. Examples of some settings and pages with different types of test questions are shown in Fig. 11.

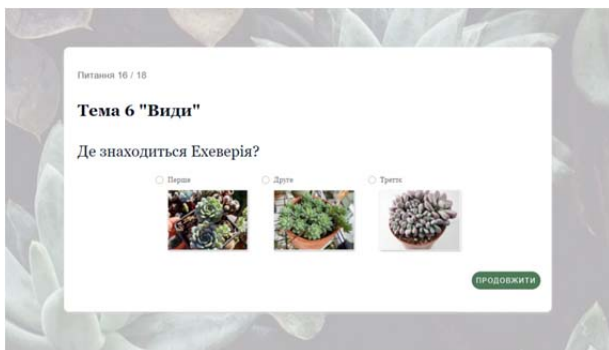
As an interactive component of MTC, a relaxation themed game “Correspondence with a friend” was developed. For this, a script of questions and possible answers was developed. Then several videos of correspondence in Telegram with a “friend” were recorded using the Bandicam program. After that, each video was adjusted separately using the InShot program in terms of length, etc. parameters and was integrated into the Adobe Captivate environment, where the game settings were directly implemented (Fig. 12).



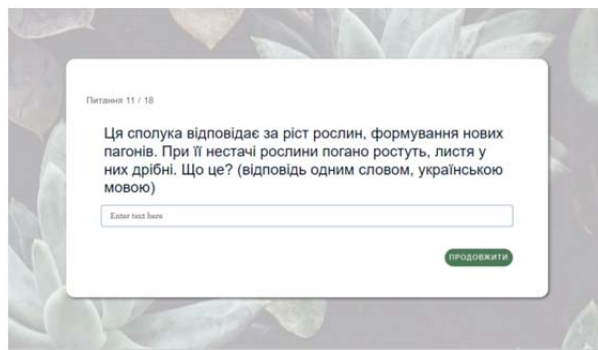
a



b

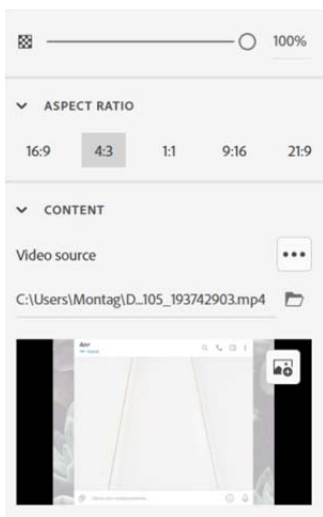


c



d

Fig. 11. Examples of settings and interactive test questions: a – test settings; b – settings of messages; c – a single-choice question with graphic visualization; d – open-ended question



a



b

Fig. 12. Setting the game size and timing: a – setting the game size; b – timing settings

The game contains 17 pages. The logic of the game is as follows: if the user has chosen an answer that requires help, the friend helps and answers several questions about caring for succulents, while a button is provided that takes the user to the next slide with questions to the friend. If the user chose the answer that no help is needed, the game ends. Depending on the selected answer, the button takes the user to the desired page, where the entire history of past answer options is saved. There are 5 different scenarios at the heart of the game, therefore, each time you can play the game in a new way, giving different options for answers. An example of one of the scenarios is shown in Fig. 13.

Instructions for tests and games, a video guide for working with the course, pages with minimum and recommended system requirements, a page with information about the course, etc., were also developed as components of the MTC.

So, the content load and features inherent in the implementation of each of the analytical and applied tasks of the MTC development process for the user's self-development have been determined. The MTC development process is shown on the example of the creation of a multimedia course "Caring for succulents" aimed at supporting the self-development of users who want to learn how to properly care for succulents. This course supports interactive interaction with the user in the process of implementing educational, developmental, and game elements. The form of providing educational material at the MTC ensures an increase in the user's interest and stimulates him/her to self-study and self-development. This is facilitated by the possibility for the user to build his/her own learning trajectory, the multi-component course, the integrity of the presentation of various types of thematic content, and interactivity. The learning process is carried out by studying the material of the multimedia manual (as the theoretical core of the course), performing interactive exercises in the form of video lessons, passing tests, and a relaxation themed game.

## 6. Discussion of results of the process of developing a multimedia training course for user self-development

Within the framework of this study, the composition and content are proposed; the specifics of analytical and applied tasks, which must be solved in the process of developing MTCs for the user's self-development, are investigated. The tasks are listed in a clear cause-and-effect sequence, indicating the result of each of them, which, in turn, serves as input information for solving the next task. The study shows a clear and logical chain of tasks from interaction with the customer to the practical implementation of MTC. The implementation of each of the tasks is illustrated by an example of its solution.

The proposed research is a continuation of our research on determining the appropriate structure, content, and interactive implementation of multimedia educational publications in the form of complexes, courses, etc.

As an advantage of the proposed composition of tasks, in comparison with works [2, 8, 9, 11], there is a separation of the task from the need to conduct keyword research by subject area. An analysis of the quantitative characteristics of search queries was carried out on the basis of processing the statistics of issuing requests to the target audience using the Google Ads service. This made it possible to determine topics that are relevant for users and should be included in the course.

Also, the advantages, when defining the components of TT, include the delineation of the situational branching according to the input information, when there is a need to solve an additional sub-task of defining structural elements, which is implemented in a complete chain of tasks of creating an MTC. Separate papers [2, 9] with scientific results in the form of developed methods address this issue.

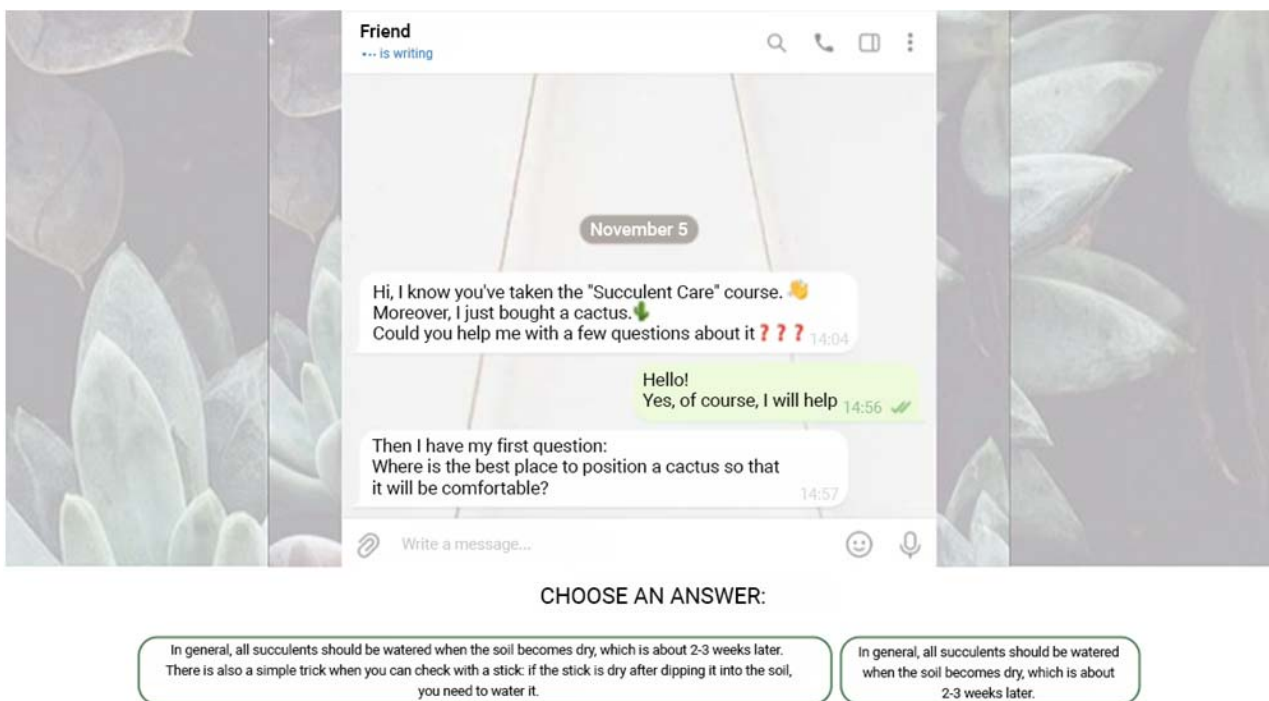


Fig. 13. An example of playing a relaxation themed game (scenario # 1)

A strong point of the research is paying attention to the process of increasing the degree of validity of decision-making regarding choosing the most appropriate software environment among alternative ones for MTC development. To this end, a sequence of steps is proposed, which makes it possible to form selection criteria, carry out their formalization, determine the weight, degree of implementation of alternatives and make a decision on choosing the most appropriate alternative (development environment). As an advantage, in comparison with [16], there is an expansion and unification of the term set based on the introduction of a variable with the value “0” into the basic set, when the implementation of the criterion in the alternative is not provided for. This eliminates redundancy when calculating the weighted score and utility function by excluding from consideration criteria that have no implementation in the alternatives.

In this study, an approach to choosing a stylistic direction of design, which will be the most appropriate for visualizing the MTC interface, is also proposed.

Possible areas of practical application of the proposed analytical and applied tasks are:

- creation of electronic multimedia educational publications for certain educational disciplines;
- creation of multimedia educational interactive complexes, courses for self-development of users in various subject areas.

We have proposed integrity of the chain of submission of tasks (from the initial contact with the customer in the brief to the implementation of the course). The determined components make it possible to establish an appropriate functionality corresponding to the analysis criteria (Table 1), as well as to develop a structural (Fig. 3) and technological scheme of the course (Fig. 4), to determine the components of the design solution (Table 3, Fig. 5, 6) and practically implement a multimedia course and its interactive component (Fig. 7–13).

The relevance, expediency of solving, and effectiveness of the given tasks are confirmed by the practical development of their sequential solution of the integrated, multi-component, interactive MTC “Caring for succulents”. The developed course ensures a high level of understanding and assimilation by users of the material on the care of these plants, activates their self-development and promotes an increase in educational self-activity. The developed MTC is used in the educational discipline “Electronic Publishing Technologies” at the Simon Kuznets Kharkiv National University of Economics (Kharkiv, Ukraine).

The disadvantage of our research is that it does not contain a justification for the choice of interactive elements, but it is immediately determined that these will be interactive tips, interactive exercises in the form of video lessons, interactive flip cards, etc. However, in the future, it is advisable to introduce a corresponding task of justifying the selection of appropriate interactive elements from the set of latent ones for implementation in the MTC interface. Moreover, it will be quite relevant to focus attention in the decision-making process on the selection of interactive elements on which self-development functions will activate and keep these interactive elements in the course. This will make it possible to make more informed decisions when choosing interactive elements for implementation within MTC.

In the process of using the results, the following limitations of a subjective nature may be imposed:

- the list of components of the brief may change according to the requirements, needs, and wishes of the customer;
- the results of search queries may vary, respectively, from the launched advertising companies of goods or services, which affects their frequency.

A further area of research may be the development of a methodology for evaluating the effectiveness of using multimedia courses for self-development of users in various subject areas.

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## 7. Conclusions

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1. Based on the analysis of key queries by subject area, performed using the Google Ads keyword statistics analysis service, topics that should be introduced into the MTC structure for self-development have been determined. Thus, as a result of the monthly analysis of requests for the phrases “succulents’ species” (the number of requests from 1 to 10 thousand/month) and “breeding succulents” (the number of requests from 100 to 1 thousand/month), they were included as separate topics that were implemented as part of the multimedia training course manual.

2. On the basis of our analysis of analogs of multimedia resources in the subject area through the prism of criteria as appropriate for the implementation of the functionality, confirmation was received that the multimedia course would not be an analog of existing resources in terms of functionality. Also, the strengths (such as interactive advice, educational game, video lessons, etc.) that were implemented in the new MTC for self-development were determined.

3. We have detailed the structure of the technical task by content and elemental composition. A visualization of the construction of structural and technological schemes for the creation of a multimedia course is provided. We reasoned a choice of the most appropriate software environment for the practical implementation of MTC. To this end, a base of selection criteria was formed, their formalization was carried out, the weight and degree of implementation of criteria according to alternatives was determined, and the utility function of choosing alternatives for the development of MTC was calculated. Adobe Captivate was identified as the most appropriate software development environment with the maximum value of the utility function – 3.26.

4. The most expedient stylistic direction of design for the formation of the MTC interface was determined. The style  $st_4$  “minimalism” was chosen as the most appropriate with the maximum weight (0.23) and the highest rank=8. Elemental components for its implementation have been determined: basic colors, visual appearance of various states of navigation and control elements. Prototypes of typical multimedia course pages were developed within the framework of the chosen stylistic direction of design. With the use of the Adobe Captivate software environment, the practical development of MTC for self-development was carried out in the amount of 74 pages. The main part of the MTC is a multimedia manual, as its theoretical core. It presents topics: transplanting, watering, placement, feeding, reproduction, species. The pages of the multimedia guide contain a lot of media content (text, photos, video lessons, etc.) and interactive objects in the form of interactive tips, flip cards, etc. MTC also includes an interactive glossary, interactive tests of varying degrees of complexity, a thematic educational

game, a video guide to the course, etc. The developed MTC is used within the educational discipline “Electronic Publishing Technologies” as an illustrative example of the process of creating (from idea to implementation) a multimedia resource for self-development of users with a multi-component interactive composition.

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#### Conflicts of interest

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The authors declare that they have no conflicts of interest in relation to the current study, including financial, personal, authorship, or any other, that could affect the study and the results reported in this paper.

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#### Funding

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The study was conducted without financial support.

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#### Data availability

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All data are available in the main text of the manuscript.

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#### Use of artificial intelligence

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The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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