Training Teachers-to-Be to Create Infographics and Its Expert Evaluation

Nadiia V. Olefirenko[1][a], Nataliia O. Ponomarova[1][b], Vira M. Andriievska[1][c], Olena O. Gulich[1][d],
Andrii Y. Gaidus[2][e] and Iryna A. Lyakhova[3][f]

[1]*H. S. Skovoroda Kharkiv National Pedagogical University, 29 Alchevskyh Str., Kharkiv, 61002, Ukraine*
[2]*Kharkiv Petro Vasylenko National Technical University of Agriculture, 44 Alchevskyh Str., Kharkiv, 61002, Ukraine*
[3]*State University of Economics and Technology, 5 Stepana Tilhy Str., Kryvyi Rih, 50006, Ukraine*

Keywords: Creating Infographics, Infographics, Young Learners, Experimental Research, Expert Evaluation.

Abstract: The study purpose is to develop methods for preparing students to create infographics for educational purposes and its expert evaluation. Creating an educational infographic is an interesting, but quite complex activity for a teacher, which requires both the expansion of existing psychological and pedagogical knowledge and skills, and the formation of new ones. The modules "Infographics in educational activities" and "Expert evaluation of e-tools' quality for teaching students" are offered for teachers-to-be. The determination of the weighting factor of each criterion by expert evaluations was organized. Experimental implementation of the developed modules is carried out. On the basis of the criterion rank, the significance of each criterion was calculated. The indicators to determine the level of preliminary expert evaluations of e-tools are proposed. The results are calculated with nonparametric methods of mathematical statistics. The conclusion is the expert evaluation has different activity stages, gradually becoming a common phenomenon.

1 INTRODUCTION

The increasing speed of the modern digital world, saturated with information and communication technologies, the habits of the modern young generation to multitasking, to the perception of a significant amount of information, lead to the need for changes in the learning process. First of all, changes and significant modernization require didactic tools used in the lesson – such tools must correspond to the methods chosen by the teacher, the specific situation in the lesson, the peculiarities of students' perception of information. In modern conditions, didactic tools should be variable, comfortable, flexible, adaptive, – those that can be changed according to existing class needs or new capabilities of technical means.

It should be noted that currently the range of available electronic tools has significantly expanded for the needs of the lesson on the methodical web portals and pages of pedagogical forums the following types of electronic resources are offered (depending on the educational purpose) (Olefirenko, 2015):

- means-sources of educational information: presentation of information about objects of study (electronic textbooks and manuals, presentations), models of objects of reality (figurative – photos, images, illustrations, videos, etc., verbal – audio recordings, sign – schemes, mental maps);

- means of organizing the assimilation of educational material (electronic simulators);

- means of control and diagnostics of educational process (means of automated testing);

- means of research, creation and reproduction of sources of information.

Infographics nowadays are one of the didactic tools widely used in education, which provide a structured and systematic visualization of models of processes and phenomena in static and dynamic form (Ivanova et al., 2020). Currently, infographics are actively used in the presentation of news or analytical data, in marketing, in journalism. Recently, in the

[a] https://orcid.org/0000-0002-9086-0359
[b] https://orcid.org/0000-0002-0172-8007
[c] https://orcid.org/0000-0003-1632-4045
[d] https://orcid.org/0000-0002-3846-1916
[e] https://orcid.org/0000-0001-8414-5765
[f] https://orcid.org/0000-0001-7589-8351

311

form of infographics provide both educational information and policy (including quite official).

There are a number of factors that motivate teachers to use infographics in the learning process:

- infographics are modern, and currently the most powerful way of presenting data, which is clear and familiar to students;

- increasing the number of infographics in the entire media product, in advertising materials, textbooks, etc. requires certain skills – read information, compare it, correctly perceive the data, analyze the data and draw conclusions, which determines the feasibility of including tasks to work with infographics in class;

- due to the brevity, conciseness of information, the ability to compare data, the availability of images that are easy to remember, students are quickly involved in the process of its consideration, in working with data;

- the use of infographics contributes to the formation of students' skills of the future – to analyze and critically evaluate information, depending on the information received to make decisions;

- dynamic infographics allow you to quickly compare data and draw conclusions;

- involvement of students in the independent creation of infographics from the school course is one of the effective ways to master the material, as it requires a lot of work to collect data, select the most useful, systematize information, design it in a convenient form;

- acquaintance with the concept of infographics and the formation of skills in the use of various methods of data presentation is provided by the curriculum of the subject "Computer Science" for students of 10-11 grades of secondary schools at the standard level and in specialized classes.

Thus, our research on the training teachers-to-be to create infographics and its evaluation is in line with current issues.

2 RECENT WORK

The problem of training teachers-to-be to create visual teaching aids is revealed in many psychological and pedagogical studies. The research (Bartlett, 1927; Bilousova and Zhyteneva, 2014; Davydov, 1988; Erdniev and Erdniev, 1976; Holub et al., 2020; Kalmykova, 1959; Kravtsov and Pulinets, 2020; Mazorchuk et al., 2020; Midak et al., 2021; Minsky, 2013; Raputo, 2010; Verbitsky and Kalashnikov,

2015) are devoted to the theoretical and methodological bases of visualization of educational material in the educational process. Despite the variety of existing interpretations of the concept of visualization, researchers agree that due to the growth of information flows visualization is a new means of reflecting the objective world in the mind of the subject, which has significant didactic potential (Raputo, 2010). Under the conditions of visualization, visual images reduce the chain of verbal reasoning and contribute to the synthesis of the image of the concept of greater capacity (Biloshapka, 2007). Visualization helps to focus on the essential components of the learning material and to understand the connections between them. On the other hand, the use of visualization brightens and makes more convincing educational material (Safina, 2010), allows you to create the effect of situational expression, an atmosphere of ease, enriches the educational process (Briantseva, 2006). It is important that visualization stimulates students to comprehend, generalize, clarify perceived images, ensures the completeness and integrity of their perception (Bilousova and Zhyteneva, 2014), activates various forms of thinking students visually effective, figurative, associative and others (Polyakova, 2012).

The development of modern visualization tools is a factor in the creation of both innovative teaching methods and new pedagogical technologies. For example, Manko (Manko, 2009) sees visualization as the basis for the formation of a qualitatively new stage of development of the fundamental principle of learning – the principle of clarity.

At the same time, Bilousova and Zhyteneva (Bilousova and Zhyteneva, 2014) emphasize the need for early preparation of teachers for the use of visualization in the educational process.

In general, the use of visualization in teachers-to-be training allows to solve a number of educational and pedagogical tasks, including the activation of educational and cognitive activities, the formation of skills of systematization, analysis, highlighting, coding and recoding of educational information, development of figurative perception and visual thinking, development of visual culture, etc. (Movchan, 2017).

In turn, mastering the basics of infographics development by teachers-to-be, in the opinion of experts, is appropriate not only in terms of acquiring skills in developing modern teaching aids, but also a powerful means of obtaining their own experience of project activities use of information and communication technologies, etc.) (Grushevskaya, 2016).

Institutions of higher pedagogical education have accumulated some experience in teaching the basics of infographics development. For example, work-

shops on information technology have been developed, the purpose of which includes mastering a wide range of the most common services of creating infographics (Ponomareva, 2015). Teachers-researchers offer separate methods of teaching infographics development in institutions of higher pedagogical education – work of Grushevskaya (Grushevskaya, 2016) presents the experience of teaching future teachers to create infographics as a multi-stage process, including goal setting, collecting and verifying information, systematization of data and concept development, prototyping, implementation.

Noteworthy are the attempts of scientists to implement new methodological approaches (e.g., acmeological) to prepare teachers-to-be for the visualization of educational information (Briantseva and Briantsev, 2019).

Equally important in this perspective is teachers-to-be training to evaluate existing and own means of visualization. According to Choshanov (Choshanov, 2013), the teacher should be able to choose and develop their own assessment methods that meet the goals and content of education, use assessment data to improve teaching, and motivate students to learn. Problems of assessing the quality of e-learning tools are highlighted in (Alkhattabi et al., 2011; Atanasova, 2019; Bilousova and Zhyteneva, 2014; Bykov et al., 2001; Elumalai et al., 2019; Ginns and Ellis, 2009; Hay et al., 2008; Iryanti and Pandiya, 2017; Kazaine, 2017; Khalid and Ziden, 2016; Leontiev et al., 2020; Little, 2003; Lytvynova, 2013; Lundqvist et al., 2006; Male and Pattinson, 2011; Marković and Jovanović, 2012; Marshall, 2012; Pons et al., 2015; Robert et al., 2016; Stasiecka et al., 2005, 2006; Vasconcelos et al., 2020; Wu and Lin, 2012; Yang et al., 2007; Zhaldak et al., 2021). In particular, Lytvynova (Lytvynova, 2013) notes that expert activity is undergoing a stage of formation, gradually becoming commonplace, and the relevance of research in the field of examination of electronic educational resources is associated with the trend of standardization and systematization of electronic educational content. To this end, there is an active discussion of various aspects of the creation and use of electronic content in the scientific circles of the National Academy of Educational Sciences of Ukraine, the boards of the Ministry of Education and Science, educational institutions and identify the need to substantiate the foundations for creating the expertise (Lytvynova, 2013).

Our previous works highlight the education potential of e-tools for teaching young learners, e-tool creation in various instrumental environments ICT use for young learner (Olefirenko et al., 2019)). However, some problems of students' training for creation in-

fografic and it evaluation have not been covered in previous research studies.

Creating quality infographics is a rather time-consuming, multi-stage purposeful activity of a teacher that requires diverse knowledge, skills and abilities. Thus, our research is *aimed* at developing methodological support for teachers-to-be in designing infographics for the educational process, as well as its expert evaluation.

3 MATERIAL AND METHODS

3.1 Explored Materials Used in the Experiment

The choice of examples of infographics and software used in the experimental study was due to the need to acquaint teachers-to-be with current trends in the presentation of information.

3.2 Methods for Investigation

The following research methods were used in a complex to solve the set tasks and achieve the goal:

- theoretical: analysis of psychological, pedagogical works, systematization of views and achievements of scientists, study of normative documents (to identify requirements for e-learning tools, determine the methodological aspects of training teachers-to-be for expert evaluation of e-learning tools);
- experimental: pedagogical experiment – for experimental testing of the research hypothesis; diagnostic – questionnaires, observations, analysis of the results of control tasks (to collect data to determine the level of formation of skills of expert assessment of students); methods of mathematical statistics (for processing the results of empirical research).

4 RESULTS

Creating infographics for the needs of the educational process is an interesting, but quite complex activity for a teacher, it requires both the expansion of existing psychological and pedagogical knowledge and skills, and the formation of new ones. Considering that at designing infographics, the focus should be done on students of a particular age with their inherent characteristics of information perception, thinking, memory, certain life and educational experience,

thinking through the content of infographics requires, first of all, such psychological and pedagogical skills: to determine the purpose development, to predict the actions of the student at working with infographics, which will really lead to the desired result, to be able to plan the actions of students so as to support the interest of the student, to avoid uniformity in the tasks. Considerable attention needs to be paid to the selection of information that should be presented in the form of infographics. To achieve that a teacher needs the ability to work with information and communication technologies for the creation and design of text materials, the ability to search and select the necessary materials in collections hosted on the network (skills to create a search query, sort found resources by various parameters, evaluate their reliability), create and prepare the illustrative materials (cutting the desired fragment, increasing or decreasing its scale, correction of color tones of the picture, overlapping one image on another, adding a text comment to the picture, etc.), skills of structuring and accumulation of prepared training materials on electronic media. It should be noted that despite the availability of a large number of illustrative materials, templates, animations, software development stored in online collections, the teacher must know and follow the general and special rules of the site for copying and using materials, preserving the rights of authors to intellectual property.

In addition, the preparation of materials requires knowledge of the teacher on the selection of color and font design, understanding of the impact of colors and their combinations on the physiological and psychological state of the student, the principles of comfortable information on the computer screen, recommendations for font design information for students of different ages.

The success of infographic training is based on the teacher's knowledge (figure 1) of the peculiarities of the student's perception of information from the computer screen; ability to analyze and recognize such situations on the screen that require adjustments in the placement of information, its structuring and design; ability to edit and correct educational materials to ensure their comfortable perception; condense educational information through accurate formulation and visualization; ability to use logical accents competently – special techniques aimed at attracting the attention of a student to a particular object.

To implement infographics, the teacher can use both universal software (for example, a program for creating presentations) and special ones, which are designed to infographic training. Therefore, the teacher needs to be acquainted with various tools in

order to choose the one that will be convenient for the implementation of the plan.

Due to the fact that the conditions of a particular lesson are unique, and the teacher is not able to carry out a full-scale experimental testing of infographics, during which errors can be identified and corrected, which is why it is important to carry out its preliminary pedagogical examination. Examination of e-learning tools (including infographics) includes the ability to assess their compliance with a set of psychological, pedagogical, ergonomic and technical requirements.

We have developed a structure of training modules "Infographics in educational activities" and "Expert evaluation of the e-tools' quality for teaching students", which are taught in the discipline "Design of didactic electronic resources" for masters-to-be in "Computer Science" or elective discipline "Visualization technologies in educational practice" for masters-to-be of any specialty.

The purpose, tasks and expected results of students after studying of the specified modules are defined (table 1). The content of modules has been developed, a set of teaching materials – demonstration materials has been prepared, the content of practical and laboratory tasks for students has been developed, tasks for independent elaboration and further discussion have been selected, a set of examples of infographics for analysis and expert evaluation has been selected.

Mastering the proposed modules included the topics presented in table 2.

The pedagogical experiment took place during 2015–2020 years on the basis of the Faculty of Physics and Mathematics of H. S. Skovoroda Kharkiv National Pedagogical University. The study involved 102 full-time and part-time students. The experimental work was carried out in several stages: preparatory, formative, control.

At the preparatory stage, an experimental and control groups were formed. To do this, we conducted a survey on the existing experience of reading the information provided in the form of infographics, on the creation of infographics to present educational material, available knowledge and skills on such activities. According to the results of the survey, we grouped students by the level of identification of their motivation, knowledge and skills in the evaluation of e-tools in four groups: low level, medium, sufficient, high. The obtained results were evaluated by non-parametric methods of mathematical statistics, in particular, by Pearson's criterion: at this stage the difference between students of control and experimental groups is insignificant. Based on the obtained data,
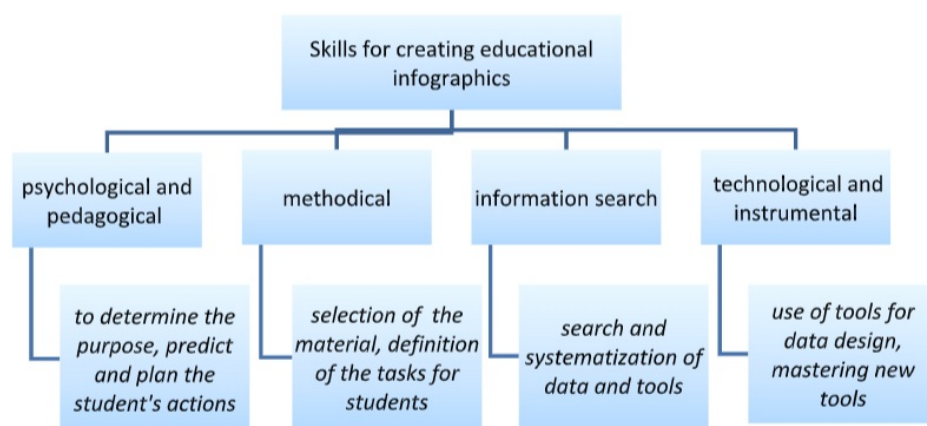
Figure 1: Skills for creating educational infographics.

the contingent of experimental and control groups of students was established – 42 students were included in the control group, 60 in the experimental group, which was due to recruitment to academic groups.

During the formative phase of the study, teachers-to-be learned to present teaching materials in the form of infographics and evaluate them using the method of expert evaluation.

Within the module "Infographics in educational activities" masters-to-be were introduced to the concept of infographics and its importance in presenting information, the historical path of its development. To understand the peculiarities of the use of infographics in the educational process, students compared the ease of perception of information presented in different ways, discussed the amount of material that can be perceived, the importance of design and more. During the practical classes we tried to structure and formalize all the results of the discussion. For example, the content of the infographic and certain features students presented in the form of a table, a diagram or a mental map (figure 2).

Teachers-to-be were acquainted with the types of infographics by the nature of visualization, selected examples of educational infographics for each type.

An essential component in mastering this module was the creation of infographics for the presentation of educational material. Note that since the course is designed for masters-to-be who already have basic skills to use information and communication technologies to design text and graphics, search for tools and install them on a computer, etc., the training was not aimed at mastering the available tools, and on formation of abilities and skills to structure educational information, to create an integral resource, to adhere to one style at registration of text materials, numerical data, illustrative images. Examples of student's

works (G. Tsekhmistrova, M. Korotetska) are shown in figure 3.

Teachers-to-be were acquainted with the system of demands for e-learning tools and for educational infographics in particular, learned to determine the degree of compliance in the e-learning tool. To this end, a number of educational infographics were demonstrated, and a discussion was held in which students found out how each of the requirements was met; how different requirements can be implemented simultaneously. During the practical classes it was important that students not only recognize how much a particular demand is met in the proposed tool, but also determine the appropriateness of the chosen methods to ensure it.

Since working with infographics should be comfortable for the student, it is important to deepen the knowledge of the primary school teachers-to-be regarding the general design of the didactic resource and ensure its ergonomics. Students in the process of practical use of various tools on their own experience were convinced that the design and ergonomics of infographics affect the user's desire to work with this resource, to perform practical tasks. In addition, it was important to consider the specifics of the student's perception of information from the computer screen and mobile devices, the impact of certain parameters of the e-tool on the psychological and physical condition of students, principles and norms of comfortable design of didactic e-resource.

In addition, it was important to develop students' ability to make decisions about the design of e-tools depending on its goal and purpose – for this purpose it was proposed to perform a number of tasks in which it was necessary to place and design the provided elements depending on predetermined conditions, to condense textual information (definitions, task texts,

Table 1: Contents of the modules "Infographics in educational activities" and "Expert evaluation of the e-tools' quality for teaching students".

Module	Purpose and objectives	Expected results
Infografics in educational activities	**Purpose**: to acquaint with the technology of creating infographics for the educational process **Tasks**: • highlight the specifics and types of infographics; • to reveal the features of preparation and implementation of infographics for various purposes; • to get acquainted with the tools for creating educational infographics.	**Knowledge**: • essence and types of infographics; • features of choosing the type of infographic for the presentation of educational information; • ways of structuring information. **Skills**: • select and structure information; • use software to prepare materials; • use tool environments to implement infographics.
Expert evaluation of the e-tools' quality for teaching students	**Purpose**: to acquaint with the technology of expert evaluation of e-means. **Tasks**: • highlight the nature and types of testing of e-learning tools; • disclose the procedure for checking e-means; • to acquaint with the principles of professional verification of e-learning tools.	**Knowledge**: • systems of requirements for e-learning tools; • essence and types of examination of e-learning tools; • quality criteria for e-learning tools;

Figure 2: Works of students G. Tsekhmistrova, I. Maistryuk.

Table 2: Topics of training modules.

Topic	Main content
Module "Infographics in educational activities"	
Essence and types of infographics. History of infographic development	Concept of infographics. Types of infographics. Characteristics of types of infographics by the nature of visualization. Research and explanatory infographics. Features of infographics as a means of learning. Historical information on the development of infographics
Infographic design technology	Content of infographic design stages. Selection of educational material for presentation in the form of infographics. Rules for designing headlines in infographics. Requirements for educational infographics. Toolkit for designing infographics for various functional purposes.
Module "Expert evaluation of the e-tools quality for teaching students"	
Psychological and pedagogical demands for e-learning tools	Psychological and pedagogical demands for all types of didactic tools – scientific, accessible, problematic, visual, educational awareness, systematic and consistent learning. Psychological and pedagogical demands that are additionally put forward to e-learning tools – interactivity, multimedia, assistance system. Requirements to be met by electronic means designed to teach students of different ages.
Ergonomic, technical and health demands for the e-resource.	The concept of ergonomics of the learning environment. Ergonomic demands for e-learning tools (for general visual design; color characteristics; spatial arrangement of objects; design of textual, numerical and symbolic information). Ways to ensure health and technical demands in the e-means.
Pedagogical examination of didactic e-resource	Content-scientific, methodical and design-ergonomic examination. Standardization of e-teaching aids. The concept of e-means certification. Criteria and indicators of quality of e-learning tool. Application of the method of expert evaluations when choosing the criteria for evaluating the quality of a didactic e-resource.

explanations, lines of heroes, etc.) which the student should read from the computer screen, competently design it taking into account the psychological and physiological characteristics of the child. Here are some examples of tasks:

1. Analyze the visual design of the proposed infographics on:

   - compliance of the general design of the infographic with its content;

   - emotions that can cause the design of the infographic in the student;

   - the presence of homogeneous or aggressive fields, the feasibility of making changes;

   - the number of objects that are currently in the user's field of view.

2. Formulate the rules of visual design of infographics, taking into account their psychological and physiological features.

3. Design material on the topic "Addressing in spreadsheets", using the provided components. Resize objects, number of slides, color scale, background, etc. Explain the need for changes made.

4. Using a color wheel, select for the specified colors that are contrasting, analogous, making a contrast triad.

5. Get acquainted with the essence of psychological and pedagogical demands that must be met by infographics. Determine how each demand is implemented in the proposed examples.

6. Analyze the infographics. Determine whether different types of fonts are used, which headset and skittle are selected. Determine the distance from which the entire presentation content is clearly visible.

During practical classes at University, students learned to identify the criteria and indicators that were essential for analyzing the quality of the author's e-tools, to analyze the compliance of professional and own developments with the selected criteria. For this purpose, the determination of the weighting factor of each criterion by the method of "expert evaluations" was organized (Orlov, 2001).

For this purpose, students identified a set of criteria for later e-tool evaluation (they minded educational principles; correlation e-tool content with the curriculum; interactivity, multimedia, assistance system; ergonomic demands).

To determine the weighting factor of each criterion, the students in academic group acted as experts and determined individually the rank of each criterion (from 1 to 4). The experimental group received the data presented in table 5.

Figure 3: Student's works of G. Tsekhmistrova, M. Korotetska.

Table 3: Table for task 4.

Name Color	Sample Image	Contrasting Color	Analogous Colors	Making contrast triad
Green				
Red				
Purple				
Light green				

Next, the concordance coefficient was calculated, which indicated the consistency degree of all students' opinion as "experts". In the experimental group the value was W = 0.57, indicating the average degree of consistency in expert evaluations. It should be noted that in the control group, after calculating the concordation coefficient, the table of criterion rank needed coordinating and editing.

On the basis of the table of criterion rank, the significance of each criterion was calculated. For that we found the values that were inverse to the rank sum for each criterion, and then determined the required weighting factors. According to the experts, the importance of each criterion was: correlation e-tool content with the curriculum – 0.35; structured, conciseness – 0.31; adherence to pedagogical principles –

0.19; adherence to ergonomic demands – 0.15.

The students chose one e-tool for self-evaluations. Every student evaluated the criterion degree in the e-tool and expressed it in points from 0 to 3. For example, 3 points for high level, 2 points for sufficient level, 1 point for medium level, 0 point for low level. After that, every student calculated the e-tool evaluation, taking into account weighting factor of each criterion (by the formula $\Phi = V_k \times P_k$, where V_k – weighting factor of each criterion on the basis of expert evaluations, P_k – the demonstration degree of each criterion).

Consequently, as a result of the e-tool expert evaluation, every student gave it a general score: 2.51–3.0 for high level, 1.51–2.50 for sufficient level, 0.76 –1.50 for medium level, and 0.0 – 0.75 for low level.

Table 4: Table for task 6.

Presentation name	Age / Grade	Headset	Font	Font height, letter height at demonstration through projector

Table 5: Table of ranks of criteria for e-tool evaluation.

Criterion	Expert														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
correlation e-tool content with the curriculum (x_1)	1	1	1	1	1	2	3	1	1	1	3	1	3	3	1
structured, conciseness (x_2)	2	2	2	2	2	1	1	2	4	2	1	2	1	1	2
adherence to pedagogical principles (x_3)	3	4	3	3	3	3	2	4	2	4	2	4	2	2	3
adherence to ergonomic demands (x_4)	4	3	4	4	4	4	4	3	3	3	4	3	4	4	4

According to the results, students did not always come to the same consensus about the e-tool quality. It indicated different experience levels of using such e-tools, subjectivity in expert evaluation. This indicates a different level of experience in the use of such tools in professional activities, subjectivity in expert evaluation.

At the same time, such activities allowed teachers-to-be to pay more attention to suggestions for improving e-tools, before giving their own evaluation about the e-tool quality.

In the final stage of the experiment, we formulated the indicators to determine the level of formation of skills to create infographics for educational purposes to carry out a preliminary assessment of its quality:

- awareness of the peculiarities of the use of infographics as a didactic tool;

- ability to structure educational material for presentation in the form of infographics and to carry out preliminary training by means of information and communication technologies;

- ability to use tools to create infographics;

- knowledge of the system of demands for e-learning tools (including infographics) for students;

- ability to use the method of expert evaluation to rank certain indicators;

- ability to assess compliance with the system of demands for e-learning tools for students.

The results of the experiment about the effectiveness of teaching students to e-tool expert evaluation based on the indicators presented in table 6. In the table, the control group is marked with letter C, and the experimental one is marked with letter E.

So, the quantitative data show that there have been significant changes in the experimental group as for teaching students for e-tool expert evaluation in comparison with the previous experiment stage: the difference between the control and experimental groups is quite noticeable in almost all indicators. For example, in the control groups the high and sufficient levels as for ability to use tools for creating infographics showed 23.8% and 16.7% of students, in the experimental – 43.3% and 31.7%. A significant difference was also found between the groups in the level of awareness of the peculiarities of the use of infographics as a didactic tool; formation of skills to use the method of expert evaluations to rank certain indicators. The obtained results were evaluated by non-parametric methods of mathematical statistics, in particular, by Pearson's criterion: the obtained values (27.8; 11.0; 12.5; 9.3; 23.8; 22.9) are significantly higher than the critical value, which indicates the effectiveness of the measures to develop students' ability to expertly evaluate e-learning tools.

5 DISCUSSION

No doubt, that a modern teacher should be trained to work in a new digital society, in the face of high expectations regarding teachers' competences relating to the development of e-tools that promote effective schooling. As for expert evaluations by students, any teacher, in our opinion, should be able to choose and develop their own evaluation methods that are consistent with lesson aims and content, to use evaluation data to improve teaching, and to motivate children's learning.

However, it should be noted some difficulties associated with training teachers-to-be to create infographics for the educational process:

- the need for creative abilities of students, the ability to creatively approach the presentation of information, the use of pictorial means, etc. – such skills can not be formed during the training module;

- the need to comprehend a significant amount of information to select the most relevant, structured

Table 6: The results of skills' formation of expert evaluation e-learning tools (percent).

Indicator	Group	Low level	Medium level	Sufficient level	High level
awareness of the peculiarities of using infographics as a didactic tool	C	42.9	28.6	16.7	11.9
	E	5.0	20.0	35.0	40.0
ability to structure educational material and carry out its preliminary preparation	C	26.2	31.0	23.8	19.0
	E	10.0	15.0	45.0	30.0
ability to use tools to create infographics	C	23.8	35.7	23.8	16.7
	E	8.3	16.7	43.3	31.7
knowledge of the system of demands for e-learning tools (including infographics) for students	C	19.0	42.9	26.2	11.9
	E	6.7	26.7	38.3	28.3
ability to use the method of expert evaluation to rank certain indicators	C	42.9	33.3	23.8	0.0
	E	10.0	16.7	33.3	40.0
ability to assess compliance with the system of demands for e-learning tools for students	C	19.0	28.6	42.9	9.5
	E	3.3	6.7	48.3	41.7

presentation as a whole;

- the need to have a sufficiently wide range of software for universal and special purposes for the design of educational information;

- practical lack of localized versions of tools focused on creating infographics, which requires students to have sufficiently developed skills of using information and communication technologies for the preparation of e- materials.

6 CONCLUSIONS

After the development and experimental implementation of the prepared training modules, we came to the conclusion that the development of educational infographics and its expert evaluation is a complex process that requires expanding existing psychological, pedagogical and methodological knowledge and skills, as well as new ones. During the experiment, students learned the features of creating infographics, its types, tools for its creation. The experimental test was successful, as it is confirmed by the methods of mathematical statistics, so we can recommend the proposed methodological support for student learning.

REFERENCES

Alkhattabi, M., Neagu, D., and Cullen, A. (2011). Assessing information quality of e-learning systems: A web mining approach. *Computers in Human Behavior*, 27(2):862–873.

Atanasova, I. (2019). A university knowledge management tool for the evaluation of the efficiency and quality of learning resources in distance e-learning. *International Journal of Knowledge Management*, 15(4):38–55.

Bartlett, F. C. (1927). The relevance of visual imagery to the process of thinking. III. *British Journal of Psychology. General Section*, 18(1):23–29.

Biloshapka, N. M. (2007). On the results of a pedagogical experiment using visualization technologies in the educational process. *Current issues of modern computer science*, 5:185–188.

Bilousova, L. I. and Zhyteneva, N. V. (2014). Didactic aspects using technology of vizualization in educational process of secondary school. *Information Technologies and Learning Tools*, 40(2):1–13. https://journal.iitta.gov.ua/index.php/itlt/article/view/1017.

Briantseva, H. (2006). Vizualization of the initial material from computer graphics for additional associative images. *Osvita Donbasu*, 6. http://alma-mater.lnpu.edu.ua/magazines/osvita-donbas/Osvita_Donbasu_2011_6.pdf.

Briantseva, H. and Briantsev, O. (2019). Acmeological approach in training teachers to visualize educational information in the process of forming the professional competence of bachelors in terms of professional and practical training. *Information technologies in education and science*, 11:57–61. https://www.researchgate.net/publication/339208605_Akmeologicnij_pidhid_u_pidgotovci_uciteliv_do_vizualizacii_navcalnoi_informacii_v_procesi_formuvanna_profesijnoi_kompetentnosti_bakalavriv_v_umovah_profesijno-prakticnoi_pidgotovki.

Bykov, V., Dovgiallo, A., and Kommers, P. A. M. (2001). Theoretical backgrounds of educational and training technology. *International Journal of Continuing Engineering Education and Life-Long Learning*, 11(4-6):412–441.

Choshanov, M. A. (2013). E-didactics: A new look at learning theory in the digital age. *Educational Technology and Society*, 16(3):673–685. http://web.archive.org/web/20170828192622/http://ifets.ieee.org/russian/depository/v16_i3/pdf/18.pdf.

Davydov, V. V. (1988). The concept of theoretical general-

ization and problems of educational psychology. *Studies in Soviet Thought*, 36(3):169–202.

Elumalai, K. V., Sankar, J. P., Kalaichelvi, R., John, J. A., Menon, N., Alqahtani, M. S. M., and Abumelha, M. A. (2019). Factors affecting the quality of e-learning during the Covid-19 pandemic from the perspective of higher education students. *Journal of Information Technology Education: Research*, 19:731–753.

Erdniev, P. M. and Erdniev, B. P. (1976). The systematization of knowledge and intensification of the learning unit. *Soviet Education*, 18(5):83–97.

Ginns, P. and Ellis, R. A. (2009). Evaluating the quality of e-learning at the degree level in the student experience of blended learning. *British Journal of Educational Technology*, 40(4):652–663.

Grushevskaya, V. Y. (2016). Methods of teaching the development of infographics in a pedagogical university. *Pedagogical education in Russia*, 7:673–685. https://cyberleninka.ru/article/n/metodika-obucheniya-razrabotke-infografiki-v-pedagogicheskom-vuze.

Hay, D. B., Kehoe, C., Miquel, M. E., Hatzipanagos, S., Kinchin, I. M., Keevil, S. F., and Lygo-Baker, S. (2008). Measuring the quality of e-learning. *British Journal of Educational Technology*, 39(6):1037–1056.

Holub, O., Moiseienko, M., and Moiseienko, N. (2020). Fluid flow modelling in Houdini. *CEUR Workshop Proceedings*, 2732:909–917.

Iryanti, E. and Pandiya, R. (2017). Evaluating the quality of e-learning using consistent fuzzy preference relations method. In *Proceedings of the 2016 6th International Conference on System Engineering and Technology, ICSET 2016*, pages 61–66.

Ivanova, H. I., Lavrentieva, O. O., Eivas, L. F., Zenkovych, I. O., and Uchitel, A. D. (2020). The students' brainwork intensification via the computer visualization of study materials. *CEUR Workshop Proceedings*, 2643:185–209.

Kalmykova, Z. I. (1959). Dependence of knowledge assimilation level on pupils' activity in learning. *Soviet Education*, 1(11):63–68.

Kazaine, I. (2017). Evaluating the quality of e-learning material. *Vide. Tehnologija. Resursi - Environment, Technology, Resources*, 2:74–77.

Khalid, N. and Ziden, A. A. (2016). Investigating the quality of e-learning technology in relation to outcomes. *Social Sciences (Pakistan)*, 11(20):4882–4886.

Kravtsov, H. and Pulinets, A. (2020). Interactive augmented reality technologies for model visualization in the school textbook. *CEUR Workshop Proceedings*, 2732:918–933.

Leontiev, D. A., Osin, E. N., Fam, A. K., and Ovchinnikova, E. Y. (2020). How you choose is as important as what you choose: Subjective quality of choice predicts well-being and academic performance. *Current Psychology*. https://doi.org/10.1007/s12144-020-01124-1.

Little, B. (2003). "Six sigma" techniques improve the quality of e-learning. *Industrial and Commercial Training*, 35(3):104–108.

Lundqvist, K., Williams, S., and Baker, K. (2006). Evaluation of quality of e-learning environments. In *Proceedings of the European Conference on Games-based Learning*, volume 2006-January, pages 216–223.

Lytvynova, S. G. (2013). To question of quality examination of electronic educational resources. *Information Technologies and Learning Tools*, 34(2):21–27. https://journal.iitta.gov.ua/index.php/itlt/article/view/812.

Male, G. and Pattinson, C. (2011). Enhancing the quality of e-learning through mobile technology: A socio-cultural and technology perspective towards quality e-learning applications. *Campus-Wide Information Systems*, 28(5):331–344.

Manko, N. N. (2009). Cognitive visualization of didactic objects in the activation of educational activities. *Pedagogy and psychology. Proceedings of Altai State University*, 2. http://izvestia.asu.ru/2009/2/peda/TheNewsOfASU-2009-2-peda-04.pdf.

Marković, S. and Jovanović, N. (2012). Learning style as a factor which affects the quality of e-learning. *Artificial Intelligence Review*, 38(4):303–312.

Marshall, S. (2012). Improving the quality of e-learning: Lessons from the eMM. *Journal of Computer Assisted Learning*, 28(1):65–78.

Mazorchuk, M. S., Vakulenko, T. S., Bychko, A. O., Kuzminska, O. H., and Prokhorov, O. V. (2020). Cloud technologies and learning analytics: Web application for PISA results analysis and visualization. *CEUR Workshop Proceedings*, 2879:484–494.

Midak, L. Y., Kravets, I. V., Kuzyshyn, O. V., Baziuk, L. V., and Buzhdyhan, K. V. (2021). Specifics of using image visualization within education of the upcoming chemistry teachers with augmented reality technology. *Journal of Physics: Conference Series*, 1840(1):012013.

Minsky, M. (2013). A framework for representing knowledge. In *Readings in Cognitive Science: A Perspective from Psychology and Artificial Intelligence*, pages 156–289.

Movchan, V. I. (2017). Preparation of future primary school teachers for the formation of students' visual thinking by means of infographics. *Bulletin of the Cherkasy Bohdan Khmelnytsky National University. Series 'Pedagogical Sciences'*, 11.

Olefirenko, N. V. (2015). *Theoretical and methodological foundations for training primary school teachers to design e-learning resources*. The thesis for doctor degree in pedagogic, speciality 13.00.04 – the theory and methods of professional education., H.S. Skovoroda Kharkiv National Pedagogical University. https://kafinfo.org.ua/images/stories/2018-2019/autoref_onv.pdf.

Olefirenko, N. V., Kostikova, I. I., Ponomarova, N. O., Bilousova, L. I., and Pikilnyak, A. V. (2019). E-learning resources for successful math teaching to pupils of primary school. *CEUR Workshop Proceedings*, 2433:443–458.

Orlov, A. I. (2001). *Expert assessments*. IVSTE, Moscow, 2nd edition.

Polyakova, E. V. (2012). Visualization as an effective method of presenting information in the mind of a person. *Almanac of modern science and education.*, (4(59)):180–181.

Ponomareva, N. O. (2015). Studying the basics of creating infographics by future teachers of computer science. *Proceedings of the international conference "New Information Technologies in Education for All"*, page 116–119.

Pons, D., Hilera, J. R., Fernandez, L., and Pages, C. (2015). Managing the quality of e-learning resources in repositories. *Computer Applications in Engineering Education*, 23(4):477–488.

Raputo, A. G. (2010). Visualization as an integral part of the teaching process. *International Journal of Experimental Education*, (5):138–141.

Robert, I., Martirosyan, L., Gerova, N., Kastornova, V., Mukhametzyanov, I., and Dimova, A. (2016). Implementation of the internet for educational purposes. *Smart Innovation, Systems and Technologies*, 59:573–583.

Safina, G. R. (2010). *Operations management*. Kazan state technological university, Kazan.

Stasiecka, A., Plodzien, J., and Stemposz, E. (2006). Measures for estimating the quality of e-learning materials in the didactic aspect. In *WEBIST 2006 - 2nd International Conference on Web Information Systems and Technologies, Proceedings*, volume SEBEG, pages 204–212.

Stasiecka, A., Stemposz, E., and Dabrowski, W. (2005). Didactic aspects influence on quality of e-learning materials. *WSEAS Transactions on Information Science and Applications*, 2(7):1002–1008.

Vasconcelos, P., Sucupira Furtado, E., Pinheiro, P., and Furtado, L. (2020). Multidisciplinary criteria for the quality of e-learning services design. *Computers in Human Behavior*, 107.

Verbitsky, A. A. and Kalashnikov, V. G. (2015). Contextual approach in psychology. *Psikhologicheskii Zhurnal*, 36(3):5–14.

Wu, H.-Y. and Lin, H.-Y. (2012). A hybrid approach to develop an analytical model for enhancing the service quality of e-learning. *Computers and Education*, 58(4):1318–1338.

Yang, S. J. H., Chen, I. Y. L., Kinshuk, and Chen, N.-S. (2007). Enhancing the quality of e-learning in virtual learning communities by finding quality learning content and trustworthy collaborators. *Educational Technology and Society*, 10(2):84–95.

Zhaldak, M. I., Franchuk, V. M., and Franchuk, N. P. (2021). Some applications of cloud technologies in mathematical calculations. *Journal of Physics: Conference Series*, 1840(1):012001.