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Application of information technologies as a significant factor in the formation of conceptual thinking of schoolchildren

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Abstract. *Problem and goal*. The article is aimed at identifying factors in the development of conceptual thinking of schoolchildren in the conditions of informatization of education. The rapid informatization of society and education makes modern teachers look for new ways to form the conceptual thinking of students, while involving the latest information and communication technologies. There is a problem of determining the role and place of conceptual thinking in the evolution of a digital society, identifying effective domestic and foreign electronic educational resources that contribute to the formation of conceptual thinking in children of different ages. *Methodology.* A model for the formation of conceptual thinking of secondary school students based on an electronic course in Spanish has been created. Experimental training of schoolchildren was carried out using educational electronic resources, the development of which was completed on the basis of taking into account the provisions of this model. *Results.* It is experimentally substantiated that the positive dynamics of the formation of the readiness of primary school students to use terminological structures is due to the identified pedagogical conditions, the introduction of the proposed teaching methods and informatization tools. As a result of the experiment, schoolchildren revealed the improvement of conceptual thinking and an increase in motivation for communication. *Conclusion.* The use of the created and tested electronic textbook helps to increase the efficiency of the formation of conceptual thinking in primary school students in the framework of teaching a foreign language. The development of conceptual thinking using a foreign language can be carried out by taking into account the described pedagogical conditions, which provide for the widespread use of modern information technologies.

Keywords: information technologies, conceptual thinking, schoolchildren, information competence, digital competence, electronic educational resource

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Применение информационных технологий как значимый фактор формирования понятийного мышления школьников

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Аннотация. *Проблема и цель.* Выявляются факторы развития понятийного мышления школьников в условиях информатизации образования. Стремительная информатизация общества и образования заставляет современных педагогов искать новые пути формирования понятийного мышления учащихся, привлекая при этом новейшие информационно-коммуникационные технологии. Существует проблема определения роли и места понятийного мышления в эволюционировании цифрового общества, обнаружения эффективных отечественных и зарубежных электронных образовательных ресурсов, способствующих развитию понятийного мышления у детей разного возраста. *Методология.* Разработана модель формирования понятийного мышления учащихся основной школы на основе электронного курса по испанскому языку. Проведено экспериментальное обучение школьников с применением образовательных электронных ресурсов, созданных с учетом положений указанной модели. *Результаты.* Экспериментально обосновано, что положительная динамика сформированности готовности учащихся основной школы к использованию терминологических конструкций обусловлена принятием во внимание имеющихся педагогических условий, внедрением предложенных методов обучения и средств информатизации. В результате эксперимента у школьников зафиксировано развитие понятийного мышления и повышение мотивации к коммуникации. *Заключение.* Использование созданного и апробированного электронного учебного пособия способствует повышению эффективности формирования понятийного мышления у учащихся основной школы в рамках обучения иностранному языку. Развитие понятийного мышления с использованием иностранного языка можно осуществить благодаря учету описанных педагогических условий, предусматривающих широкое применение современных информационных технологий.

Ключевые слова: информационные технологии, понятийное мышление, школьники, информационно-цифровая компетентность, электронный образовательный ресурс

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Problem and goal. The Russian education system has recently been undergoing constant changes. The modernization of the educational process systematically leads each teacher to understand the need to search for such pedagogical technologies that could interest students and motivate them to study the subject. Motivation is the most important component of the structure of educational activity, and developed internal motivation is the main criterion for a person. It lies in the fact that the child enjoys the activity itself, the importance of its immediate result for the individual [1].

The strategy for the development of education directs the activities of teachers and scientists to search for alternative models for the organization of education and the formation of a safe educational environment in the context of informatization. Digital technologies have become essential components of the new educational environment at all levels of the education system, which led to the emergence of new requirements for all participants in the educational process, especially teachers and students [2]. One of the key components of the new formation school formula is an innovative type of education based on the formation of competencies necessary for successful self-realization in society [3], among which are mathematical and information-digital competence. In turn, one of the components of mathematical competence is the culture of logical and algorithmic thinking [4], which, no doubt, plays one of the key roles in the formation of a conscious person who is confident in his judgments and is able to think logically not only within the framework of exact disciplines and apply the skill in any area of its activity. A necessary component of such a skill is conceptual thinking, that is, a certain minimum of logical operations necessary for each intellectual person to operate with basic and fundamental concepts.

The need to master the skill of conceptual thinking of a person in the 21st century is indicated in the digital competence framework of citizens DigComp 2.0. The rapid informatization of society and education makes modern teachers look for new ways to form the conceptual thinking of students, while involving the latest information and communication technologies (ICT) [5].

In this regard, there is a *problem* of determining the role and place of conceptual thinking in the development of a digital society, identifying effective domestic and foreign electronic educational resources that contribute to the development of conceptual thinking in children of different ages. The solution of such a problem will make it possible to substantiate the possibility and expediency of using information technologies to solve pedagogical problems related to the formation and development of conceptual thinking in schoolchildren.

M.K. Akimova, V.T. Kozlova and N.A. Ferens the specificity of conceptual thinking was considered, which consists in operating with concepts, judgments, conclusions based on the laws of logic [6]. Part of the research is devoted to the study of didactic conditions for the formation and development of conceptual thinking and considers various approaches to organizing the formation of conceptual thinking in schoolchildren [7].

O.V. Bulatov and V.I. Koroleva argue that the modernization of the education system is aimed at shaping a person who is able to solve problems in nonstandard conditions, flexibly and independently use the acquired knowledge in a variety of life situations. In this regard, the main task of the school is to provide conditions for the development of the personality of each student, the key competencies that form the basis of the ability to learn and the system of fundamental elements of scientific knowledge that underlie the modern scientific picture of the world. Teaching scientific knowledge at school determines the development of scientific concepts. Learning success is directly related to this type of thinking [8].

In the article by V.E. Steinberg emphasizes not only the importance of developing conceptual thinking, but also the need to find effective teaching aids. Regardless of the chosen direction of study, it is important to take into account

the development of conceptual and graphic visual aids in the form of visual didactic regulators. However, the literature review conducted in the article [9] proves a clear lack of research and development in the field of didactics of the conceptual-graphic type. However, the improvement in the functionality of conceptual and graphical tools is explained by the application of the principles of cognitive-visual representation of knowledge and the method of logical-semantic modeling.

As emphasized by S.A. Gilmanov, in the scientific works of psychologists and teachers, the phenomenon of conceptual thinking and the methods of its formation are considered very versatile and deeply. However, there are practically no approaches to the study of this side of conceptual thinking in humanitarian activities, including pedagogy and psychology. The importance of the competent use of concepts in reasoning, in solving intellectual problems is also spoken by experts in the development of critical thinking. This method is also actively used in the practice of foreign language education [10].

The goals of teaching a school course in a foreign language are formulated based on the general goals of the educational process in general educational institutions, as well as on the features of the discipline as a science, its place and role in the life of the modern information society and in the system of sciences [11].

In the curricula for the middle classes of general educational institutions, the goals for the development of conceptual thinking are formulated in the following form:

– development of logical, systemic thinking and the main types of mental activity: the ability to use induction, deduction, analysis, synthesis, draw conclusions, generalizations;

– formation of a theoretical knowledge base of students about the processes of transformation, transmission and use of information, disclosure of the meaning of information processes in the formation of basic concepts;

– development of the ability to solve meaningful problems of different levels of complexity, using well-known theoretical positions and logic within the framework of operating with basic concepts.

One of the recent pedagogical innovations is the use of symbolic systems, the integration of which into the educational process is developing in parallel with the growth of informatization. Modern children are audiovisual by nature, so they remember what they hear by 15%, see by 25%, and when these processes are combined, the level of memorization increases to 65% [7]. In this regard, it becomes possible to widely use ICT for the development of conceptual thinking, memory, imagination, and attention of students in average schools. However, the use of only one type of ICT in teaching a foreign language to children in secondary school may reduce interest in the process. Therefore, it is important to take into account the pedagogical possibilities of the above-described ICT for the development of conceptual thinking (Table 1).

Today, there are many examples of the use of ICT aimed at developing conceptual thinking in a playful way, and world practice shows that the number of relevant resources is constantly growing, their quality is improving, and the audience of users is expanding. The importance of the development of conceptual thinking for a modern person is indicated by the presence of complex electronic resources that allow you to train the logic of thinking at any age to develop the skill of operating with concepts. One of the reasons for this need is the influence of

the same digital technologies, which, in particular, are characterized by huge amounts of information and a decrease in the concentration of users' attention [12].

Table 1

Possibilities of the main types of ICT in the process of learning a foreign language of children of secondary school age

Functions	Type of ICT						
	For studying			For the development of types of speech activity			
	Phonetics	Grammar	Vocabulary	Listening	Reading	Writing	Speaking
E-books	–	+	+	+	+	–	–
Sites	–	+	+	+	+	–	–
E-dictionaries	–	–	+	–	+	+	–
Mobile applications	+	+	+	–	–	–	+
Presentations	+	+	+	+	+	–	–
Video footage	+	–	+	+	–	–	+
Simulators	+	+	+	–	+	+	+
Computer programs	+	+	+	–	+	+	–
Game programs	+	+	+	–	+	+	–

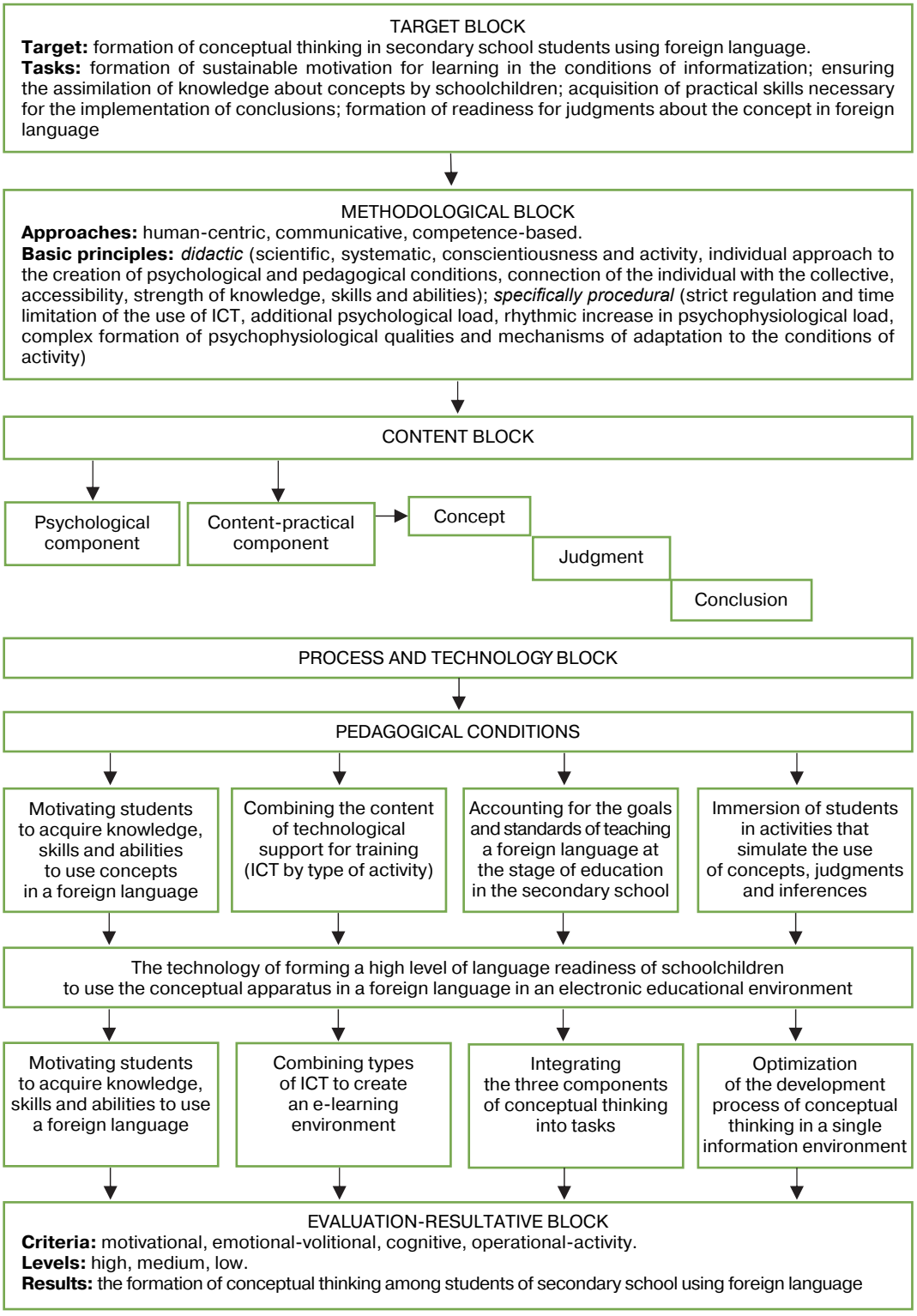
The development of conceptual thinking is devoted to multi-vector sites with databases on basic concepts in any field of science, services with tasks for the development of non-standard thinking, riddles, etc. Note that very often on such resources, tasks are not dynamic or interactive, but are presented in text form, and the answers to them are hidden and submitted after the condition [13].

Of course, the development of conceptual thinking of students of different ages is inextricably linked with the study of basic concepts [14]. Therefore, ICT can be used situationally, during the development of non-standard training sessions or extracurricular activities. For example, the world-famous resource LearningApps,[1] which contains dozens of templates for developing learning tasks, including logic, which has powerful functionality for developing various tasks, will be an excellent tool for a creative teacher [15].

In the course of the study, the assumption is substantiated that the use of sign-symbolic means in the learning process forms the conceptual thinking of students, facilitates the assimilation of material when studying complex concepts.

Methodology. On the basis of the above theoretical provisions, a model for the formation of conceptual thinking of elementary school students was developed on the basis of an electronic course in Spanish. The model of the formation of conceptual thinking of secondary school students in the study of the Spanish language is presented in the form of a schematic representation of the didactic process aimed at forming the conceptual thinking of secondary school students to use information support tools based on both well-known general didactic principles and specific procedural principles. A schematically proposed model of informatization of teaching a foreign language for the formation of conceptual thinking of secondary school students is shown in Figure 1.

[1] LearningApps. Available from: https://learningapps.org/ (accessed: 14.12.2019).



Model of informatization of teaching a foreign language for the formation of conceptual thinking

This approach can be very useful for people with poor foreign language training, as it provides an opportunity to improve knowledge of a foreign language with an emphasis on acquiring listening and speech skills to learn how to

operate with previously learned concepts. It is especially important to develop a positive motivation for learning a foreign language among students, as well as to form the ability and readiness to use the skills of conceptual thinking in teaching a foreign language [16]. The use of information and communication technologies in practical classes in the discipline "Foreign Language" contributes to a more successful formation of the conceptual thinking of primary school students.

The use of ICT in practical classes in a foreign language includes:

– educational resources of the Internet;
– electronic dictionaries and reference books;
– DVDs and CDs;
– video and audio equipment;
– multimedia presentations.

Results and discussion. Within the framework of this study, the results of an experimental verification of the effectiveness of the use of information technologies for the formation of conceptual thinking in schoolchildren are presented [17]. The analysis of the presented learning technology based on the methodology of modeling educational processes and creating an information educational environment was carried out based on the results of a mathematical assessment of the effectiveness of the results obtained.

Table 2

Assessment of the levels of formation of oral skills in the assessment of conceptual thinking by students of grade 5

Criteria	Indicators	Score		
		3	2	1
Structural organizational chart	1. The ability of students to compose their own statement of three parts	The statement has three clearly distinguished parts: thesis, proof, conclusion	A statement has two parts: a thesis with proof or proof with a conclusion	The statement consists of one part or a list of non-essential arguments
Content characteristic	1. Ability to discover new concepts in one's own statement	The statement includes five or more detailed micro-themes about a new concept (semantic field)	The composition of the statement includes 3–4 abbreviated semes	In the statement, 1–2 semes are outlined, which are represented by separate parts of the concept under consideration
	2. The ability to identify and reveal cause-and-effect relationships in the semantic field	The proof is solid, consistent, detailed. With a sufficient (3–4) number of arguments in which causal, temporal, conditional relationships are transmitted	The proof is sequential, with at least 3 arguments, in which cause-and-effect relationships are conveyed	The statement lists insignificant arguments that reveal cause-and-effect relationships
Ways of connection between sentences and parts of one's own statement	1. Ability to use various types of communication	Between sentences, a causal or parallel relationship is established that unites them	A causal relationship is established between sentences	A formal-logical connection is established between sentences
	2. Availability of language means of communication	Parts of the statement are interconnected by plug-in modal words, unions	Parts of the statement are connected to each other only by conjunctions	Parts of the statement are not connected to each other even by conjunctions
Volume of own statement	1. The presence in the statement of sentences of various composition, and their quantitative and verbal content	The presence in the statement of sentences, among which are complex subordinates of various types, impersonal; the average number of words is 50–40	The presence in the statement of sentences, among which there are complex (reasons), compound; average number of words – up to 35	The presence in the statement of sentences, among which there are simple, compound, or only the contracting part of a complex contract sentence; average number of words – up to 25

The purpose of the study was to determine the forms and level of development of conceptual thinking among 120 students of the 5th grade of general education schools. The students were divided into two groups – experimental (EG) and control (CG). The methodology for assessing the levels of development of language skills in the course of assessing the conceptual thinking of fifth graders is presented in Table 2.

In order to identify the effectiveness of introducing technology into the educational process, proposed by the author as part of the study of a foreign language, classes were organized in an electronic learning environment based on a number of educational principles. In CG No. 1, classes were conducted according to the traditional principle of education: schoolchildren studied according to a program that did not provide for the use and combination of traditional lessons and ICT. In the second EG, classes were conducted according to the proposed communicative-oriented pedagogical language technology, taking into account the human-centric, competence-based and communicative approaches to learning using an electronic manual and applying appropriate pedagogical conditions. The training took place in three stages: propaedeutic, professionally oriented, control.

During the formative stage of the experiment, a retest of the questionnaire and survey was carried out in the CG and the EG to determine the levels of formation of the psychological component according to motivational and emotional-volitional criteria in accordance with the selected methods. Determination of the levels of formation of the content-practical component (cognitive and operational-activity) was carried out through a post-experimental cut.

Let us consider in more detail the results obtained in terms of the level of formation of the psychological and content-practical components of the conceptual thinking of students of the basic school in the CG and the EG after the formative experiment and carry out their comparative characteristics.

So, the levels of formation of the psychological component were the first to be determined using the methodology of L.N. Vavilova [18]. Data on the result is given in the comparative Table 3.

Table 3

Distribution of students from the CG and the EG in proportion to the levels of formation of the psychological component of conceptual thinking according to motivational criteria before and after the formative experiment

Groups	Levels	Percentage value before the experiment	Percentage value after experiment	Difference, %
CG	High	18	45,5	+27,5
	Middle	72	54,5	–17,5
	Low	10	0	–10
Both		100	100	
EG	High	82	84	2
	Middle	18	16	–2
	Low	0	0	0
Both		100	100	

Analyzing the results on the levels of formation on motivational aspects in the EG, let's summarize that the level of motivation for new knowledge and the state of satisfaction with the skills of inference were at a high level before

the experiment, which amounted to 82% and, accordingly, increased by 2% after the end of the experiment. According to the comparative characteristics of the two groups from the CG and the EG, we have the following results: the percentage value of motivation in the EG is higher by 38.5%.

As part of the post-experimental cut, it was envisaged to perform a repeated comprehensive control work, the results of which are presented in Table 4. As can be seen from that table, the indicator of high and medium levels of formation of the content-practical component of conceptual thinking according to the cognitive criteria of students in the CG was 48 and 44% respectively.

Table 4

Distribution of students from the CG and the EG in proportion to the levels of formation of the content-practical component of conceptual thinking according to cognitive and operational-activity criteria after the formative experiment

Criteria	Levels	CG				EG			
		Qty of students	Average score	Total score	%	Qty of students	Average score	Total score	%
Cognitive	High	16	90	1440	48	28	93	2604	83
	Middle	14	81	1139	44	6	85	510	17
	Low	3	71	213	8	0	0	0	0
CG + EG		33		2791,8	100	34		3114	100
Average score			84,6					91,6	
Operational-activity	High	11	92	1012	32	23	91	2097,2	67
	Middle	18	76	1362,8	54	9	85	765	26
	Low	4	63	252	14	2	70	140	7
CG + EG		33		2871	100	34		3002,2	100
Average score			79,6				88,3		

Students from the EG show a positive dynamics of high-level changes, which amounted to 83% after the experiment through the introduced pedagogical conditions, namely: the combination of the content of the traditional approach and the information environment in the process of developing the conceptual thinking of students; taking into account the goals and standards of the Federal State Educational Standard for language training; “immersion” of students in the e-learning environment. It is necessary to focus on the fact that the average score of the groups of students from the CG and the EG confirmed the average level of readiness in the CG 84.6 points and the high level in the EG 91.6 points, as shown in Table 5.

Table 5

Distribution of students from the CG and the EG in proportion to the levels of formation of the content-practical component of conceptual thinking according to cognitive and operational-activity criteria before and after the formative experiment

Groups	Levels	Before forming experiment, %		After forming experiment, %		Difference, %	
		Cognitive	Operational-activity	Cognitive	Operational-activity		
CG	High	40	33	48	32	+8	–1
	Middle	47	37	44	54	–3	+17
	Low	13	30	8	14	–5	–16
EG	High	58	22	83	67	25	45
	Middle	35	46	17	26	–18	–20
	Low	7	32	0	7	–7	–25

The data in the table show that the high level of formation of the content-practical component of conceptual thinking in terms of cognitive and operational-activity criteria in the EG increased by 25 and 45% respectively, and the average level decreased by 7 and 25%. There were no significant changes in the relatively high level of students in the CG, only an increase of 8% in indicators according to cognitive criteria was recorded, a decrease in the low level by 16% and an increase in the average level by 17% according to the operational criterion were revealed.

Thus, the effectiveness of the process of learning and developing language skills, organized with a communicative-oriented pedagogical language technology for the formation of conceptual thinking of primary school students to use an electronic manual, was verified by determining the levels of formation of the psychological and content-practical components of the conceptual thinking of students in the control and, accordingly, experimental groups. These results are presented in more detail in the summary Table 6.

Table 6

The results of the formation of the psychological and content-practical components of the conceptual thinking of the students of the basic school from the CG and the EG before and after the experiment

Criteria	CG before the experiment		CG after the experiment		Difference, %	EG before the experiment		EG after the experiment		Difference, %
	Level	%	Level	%		Level	%	Level	%	
1. Motivational	High	18	High	45.5	+27.5	High	82	High	84	2
	Middle	72	Middle	54.5	−17.5	Middle	18	Middle	16	−2
	Low	10	Low	0	−10	Low	0	Low	0	0
2. Cognitive	High	40	High	48	+8	High	58	High	83	25
	Middle	47	Middle	44	−3	Middle	35	Middle	17	−18
	Low	13	Low	8	−5	Low	7	Low	0	−7
3. Operational-activity	High	33	High	32	−1	High	22	High	67	45
	Middle	37	Middle	54	+17	Middle	46	Middle	26	−20
	Low	30	Low	14	−16	Low	32	Low	7	−25

As can be seen from the presented table, we observe a growth trend in the indicators of the average level of formation of the components of the psychological and content-practical readiness of students in the CG. So, for example, the operational and activity criterion – by 17%. We observe a slight increase in a high level according to the cognitive criterion – (+8%) and the motivational criterion – (+27.5%).

The students of the EG after training on the introduced technology are dominated by a high level of all components of the basic school students to use the skills of conceptual thinking. Thus, the psychological component according to motivational criteria, having a high level in the EG before the experiment, increased by 2% after the experiment.

The effectiveness of the conducted experimental work was verified on the basis of a comparative analysis of quantitative and qualitative changes in the indicators of the experimental and control groups at the beginning of the formative stage of the experiment and after its completion. The results of the study to verify the experimental work on the profile are presented in Table 7.

Table 7

Dynamics of formation levels of conceptual thinking in secondary school students using foreign language before and after the formative experiment

Levels	Control Group					Experimental Group				
	Before the experiment		After the experiment		Increase	Before the experiment		After the experiment		Increase
	Persons	%	Persons	%	%	Persons	%	Persons	%	%
High	10	41.50	14	40.75	0.75	19	55.17	25	72.50	+17.33
Middle	15	45.67	16	49.00	+3.33	12	34.83	8	23.33	–11.50
Low	8	12.83	3	10.25	–2.58	3	10.00	1	4.17	–5.83
Total	33	100	33	100		34	100	34	100	

As the data in the table show, according to the results of the ascertaining section, 55.17% of students in the experimental group belonged to a high level of formation of conceptual thinking of students using FL, and after the formative experiment – 72.50%. There was an increase of 17.33%. Decreased by 11.5% indicators of the average level of formation of the indicated readiness from 34.83 to 23.33%. Accordingly, the number of students in the experimental group with a low level of conceptual thinking using FL decreased from 10.00 to 4.17%, with a difference of 5.83%. In the control group, the indicators of the levels of formation of students' conceptual thinking with the use of FL did not undergo significant changes. According to the results of the control section, a high level was inherent in 40.50% of students; the average covered 49%. With a low level after the ascertaining cut, they were 12.83%, and at the end of the formative stage of the experiment – 10.25%, there was a decrease by 2.58%.

Conclusion. After analyzing the principles and methods of creating an experimental manual to enhance the development of conceptual thinking in foreign language lessons, we can come to the following conclusions.

The purpose of creating an electronic manual developed within the framework of this study is the comprehensive formation of the student's skills and abilities in all types of speech activity: speaking, reading, listening and writing. The achievement of this goal should be facilitated, in particular, by a clear structure for studying new concepts in a foreign language: the division of material not only into thematic blocks (lessons), but also the same type of distribution of material within each lesson according to the type of auxiliary means of informatization of education. This approach helps to meet the needs of each student and help him achieve his learning goal.

The analysis of the results of the ascertaining section of the introduced material of the manual on activating the skills of conceptual thinking in the lessons of a foreign language confirmed the effectiveness of the work done. It is proved that the effect of the positive dynamics of the levels of formation of the readiness of primary school students to use the target structures is due to the introduction of reasonable and proven pedagogical conditions, and the experimental methodology of the electronic manual.

An analysis of the results of the formation of students' conceptual thinking using a foreign language (stating cut), found using diagnostic methods (learning motivation of students (L.N. Vavilova), author's test tasks and comprehensive control work, showed that, in general, the vast majority of students have an aver-

age (76.5%) and low (17%) levels of formation of conceptual thinking using foreign language according to criteria (motivational, cognitive, operational and activity).

An experimental verification of the correctness and high efficiency of the pedagogical conditions showed positive changes in the levels of formation of the conceptual thinking of students of the basic school towards communication.

After the formative experiment, the students of the secondary school of the experimental group showed an increase in language readiness to use a foreign language (from 55.17 to 72.50% (+17.33%)), and a decrease in the average level indicators (from 34.83 to 23.33% (–11.50%)) and low (10.00 to 4.17% (–5.83%)). In the control group, the corresponding levels did not change significantly: high (–0.75%), medium (+3.33%), low (2.58%).

The developed methodological recommendations will make it possible to form the professional readiness of primary school students using a foreign language with the help of the proposed communication-oriented and other concept-oriented learning technologies, taking into account the interdisciplinary links presented in the author's manual.

The search for opportunities for teachers to independently create electronic educational resources for the development of conceptual thinking, taking into account the peculiarities of learning using ICT in specific conditions, is an urgent problem, which will be addressed by our further research in this direction.

As a result, it was determined that the formation of conceptual thinking of primary school students using a foreign language can be carried out by providing appropriate pedagogical conditions:

1) motivating students to acquire knowledge and skills using a set of adapted learning informatization tools;

2) combining the content of the standard teaching methodology and the electronic manual during the communicative and language training of students;

3) taking into account the goals and standards of the Federal State Educational Standard for the language training of secondary school students;

4) "immersion" of students in the e-learning environment.

Appropriate pedagogical conditions will provide secondary school students with a range of skills that are necessary for the development of conceptual thinking, which will allow them to effectively apply knowledge using a foreign language in a thematic communication environment.

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