Information Modeling Technology in The Conditions of Students Visual Learning

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Abstract

In the article, on the basis of a theoretical analysis of modern trends in the development of the learning practice in higher education, some ways of integrating the information modeling technology into the process of students visual learning are shown. The study was limited to mental modeling, including actions and operations, without which it is impossible a complex process of constructive and meaningful analysis of different information and its use in the building of models. It is shown that in terms of visual learning it is possible to use different modeling options - visual (visual analogues, diagrams); sign (ordered, topological, graph recording); mathematical (equivalent circuits, program replacements). It is noted that in the students activity in educational modeling, the emphasis should be shifted to such types of actions as: transformation of connections and systematization of the simulated structure's elements in order to highlight the principle of its construction; fixing the properties of the structure in the subject, graphic or sign models; fixing methods of action in graphic or sign models (construction of schemes of action); modeling changes in the structure of the studied object, etc. Special attention in the article is paid to the correlation of the operational and constructive-informative ways of analyzing the objects studied by students.

Keywords: modeling, information modeling, information modeling technology, visual learning.

1 Introduction

The development of modern science and technology requires the readiness of university graduates to solve creative problems, which is possible only if the universities themselves will improve the forms and methods of professional training of students. Today, such improvement is directly related to the use of computers and their accompanying software. They not only expand the opportunities of the theoretical and practical base for organizing training for

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various disciplines, but also promote development of the students creative abilities, arming them with modern methods of learning. Special value among them is information modeling, which is understood as the study of objects, phenomena or processes on their information models.

An information model is an approximate description and a possible demonstration of an object, process or phenomenon that is significant from the point of view of learning objectives and implemented by means of information technology.

The practical application of information modeling implies the ability to analyze various types of information, to use visibility, its descriptive, schematic or symbolic form.

P.F. Kapterev [Kap82], referring to the visibility problem, wrote: "If learning should be based on the natural course of human development, then it should start with the same thing as nature begins - to induce a person's sensual mind and gradually translate it to distractions. Visual learning is the only correct and natural method of education, fully responding to the development of individuals. "

E.G. Mingazov [Min86] believes that the term "visibility" should be considered in three senses: 1) as an object; 2) as a property of real objects; 3) as a specific activity on the use of visibility.

All this is possible in the organization of visual learning - such a didactic process in which the operation of visual images takes place with the aim of:

- fixing and transmitting information of a certain type [Pos89];
- the development of students not only visual, but also motor sensations [Pol07];
- the use of linguistic and extralinguistic means [Gor18].

Achieving the results of visual learning is directly related to the ability of the subject to see the unity of the properties of the object and model in one of three aspects: structural (from the side of the model and the object structure), functional (from the work of the main mechanisms of the object and the model structure) and informational (from the information, which the model and the object contain).

The main and most common requirement for modeling is the materiality of the similarity and the irrelevance of the difference between the model and the original in the context of a specific cognitive task.

In psychology modeling is considered a product of complex cognitive activity. The positive aspects of modeling are: the ability to go beyond the border of the sensually achieved reflection of hidden essential connections and relationships of things - a combination, linking various sensory images, a recovery of scientific information from memory; scientific prediction of the events course, processes in the conscious formulation of not only immediate, but also distant goals, the development of plans for activities and projects; the implementation ideal action models in practice [Dos17].

The problem of modeling is widely discussed in pedagogical sources [Vez14] [Pan18], [Zen18] and others. Appeal to scientific sources shows that the concept of "modeling" has at least three meanings: 1) the method of objects cognition through their models; 2) the process of building these models; 3) the form of cognitive activity. The most common is the first option. From the whole variety of definitions, from our point of view, the most acceptable is the formulation given by I.B. Novik and A.I. Uemov [Nov68]: modeling is "an indirect practical or theoretical study of an object where is studied not itself an interested object, but some auxiliary natural or artificial system (model):

- located in some objective accordance with a cognizable object;
- able to replace it at certain stages of knowledge;
- giving while researching, ultimately, information about the simulated object" .

Note that in everyday life a person uses modeling in the form of intuitive analogization for many thousands of years. But as a strict scientific method, it has only a few decades. Today, modeling has acquired a general scientific character and is used in studies of living and inanimate nature, in the sciences of man and society, in forming approaches to the construction of new pedagogical systems and technologies for informatization of education [Gor09].

Along with the term "modeling" in the scientific lexicon, the term "Building Informational Modeling" is used, implying the process by which the object information model is formed. From the theory of information modeling, it follows that the information model acts as a set of interrelated descriptions of concepts about the subject of study based on the use of sign systems. The information model reflects the qualitative and quantitative properties of the objects that make up the subject of study, as well as the logical, functional, spatial and temporal relations between them.

In other words, the possibilities of the information modeling method are unlimited. It can be used to create a variety of models for:

- determining the characteristics of the objects and processes under study; understanding the essence of phenomena and developing the ability to control them; building new or upgrading existing facilities;

- making informed decisions; anticipating the consequences of their activities;

- obtaining new information about the object based on the model;

- integration and systematization of information about the object; saving and transferring information about the object modeling.

However, it should be borne in mind that information models used for educational purposes, as a rule, are not universal. Each of them is designed to simulate a fairly narrow range of phenomena. Based on the technology of mathematical modeling, models can be used not only to demonstrate phenomena that are difficult to reproduce in a learning environment, but also to interactively determine the degree of influence of certain parameters on a simulated system or situation.

As our studies show, in the practice of training future specialists, information modeling significantly increases the level of knowledge acquisition, speeds up the process of the practical skills formation. This happens due to the involvement of the subject in the process of modeling his imagination, which arises from the need to anticipate, explain the incomprehensible, to have an impact on him. At the same time, imagination can be considered both as a process and as a result of the reflection of objective reality. It is mediated by a certain target setting and performs a heuristic (serves as a factor in search creative activity) and anticipating (anticipates forms of activity) functions.

To apply the method of information modeling in the educational process, it is necessary to know technologies of working with information, which involves the use of spatial visibility, as well as its descriptive or sign forms [Tyn03]. In turn, this requires the ability to see the unity of the properties of the object and the created model in one of three aspects: structural, functional and informational. As our experience shows, the formation of such skills most successfully takes place under conditions of visual learning, i.e. such a didactic process, which is based on the extensive use of visibility and modeling in the educational and cognitive activity of students.

The analysis of literary sources undertaken by us [Men2000], [Gui06], [Had04], [Bou18], [Geb18], devoted to the problem of modeling, allows us to conclude that a number of theoretical issues have already received sufficient justification. Among them: the possibilities of the method and the laws of its inclusion in cognitive activity; methods and means of enhancing cognitive activity based on modeling; classification of models created in the process of modeling and their practical value, etc. At the same time, the issues related to the information modeling technology in the structure of students visual learning have not been studied enough.

2 Task

Based on the analysis of the problem, the study set the following tasks: 1) to identify the didactic possibilities of the information modeling method in the educational activities of students in conditions of visual learning; 2) to implement the process of mastering the technology of information modeling by students in the context of future professional activities; 3) to experimentally prove the effectiveness of information modeling technology as a method of improving the practice of teaching students in high school.

3 Development Of Methodology

In determining the research methodology, we proceeded from the tasks. In this regard, first of all, it required an refer to the method of logical analysis of scientific sources, in which judgments about concepts are presented - model, modeling, information modeling, information modeling technologies. The definitions of concepts presented in them were considered by us as some completed structures. Such an approach was justified because it prepared the ground for moving in the opposite direction - to synthesis, on the basis of which generalizations were made and models were created, and didactic possibilities of information modeling were studied in providing students with more productive learning activities with information in the context of visual learning.

The solution of the research tasks was also connected with the method of ascent from the abstract to the concrete, the specificity of which was the development by students of various types of information models and endowing them with the properties of ideal images. Models were used as simulated objects:

at the empirical level:

- reconstructing (recreating the qualitative specificity of the object);

- measuring (obtaining quantitative characteristics of the object);

- descriptive (providing visibility and clarity);

at the theoretical level:

- interpretative (explanation, generalization, comprehensive description);
- predictive (predicting the behavior of the prototype object);
- criterion (verification of truth, the adequacy of knowledge about the object);
- heuristic (hypothetical representation of the object);

at a practical level:
- cognitive-illustrating;
- training.

The process of information modeling itself was carried out on the basis of the pedagogical experiment method, consisting of two stages - forming (conducted in the experimental group) and final (obtaining empirical data in the experimental (EG) and control (CG) groups). The main method of obtaining empirical data was survey, suggesting the respondents' answers to specific tasks by means of reflexive thinking [Kib15], [Ris16], [Byrd17]. In this regard, the tasks were used to establish:
- the attitude of students to mastering the information modeling technology is the leading motive type;
- the degree of knowledge assimilation about the modeling method (cognitive component of IC; qualitative and quantitative analysis);
- the degree of knowledge assimilation about the diversity models' types and functions;
- the degree of students' understanding of the information modeling technology role in the structure of future professional activity;
- mastery of knowledge about information technologies and the skills to use them for processing information;
- the ability to create various types of models: informative, structural-logical, functional;
- the ability to use various types of graphical visibility in the process of information modeling.

Tasks were given to the subjects in turn and performed them in writing. In assessing the results of the tasks, an expert assessment was used, which did not allow subjectivity due to the fact that the expert had reference standards.

The study involved students from the 1-2 grades of the master's program in the direction of "Pedagogical education" from several institutes of the "North-Caucasian Federal University" . The total number of respondents was 80 people.

4 Results

The main results of the study, obtained on the basis of the survey-diagnostic method and comparative analysis, are presented by us in the sequence as they were made available to experts.

4.1 Students' Attitude To Mastering Information Modeling Technology Is The Leading Type Of Motive

A leading type of student motive was subjected by the study. For the study the task formulated in the form of a question was used: "What is the most important for you in mastering information modeling technology?".

Table 1: Comparative analysis of the motives of students mastering the information modeling technology, in % of the total number

Respondent Assessing parameter	Students in the experimental group		Students in control group	
	1 grade	2 grade	1 grade	2 grade
Possible use in the profession	43,0	73,0	37,0	34,0
Desire to learn something new	29,0	48,0	27,0	33,0
Attracts the possibility of self-realization	23,0	46,0	21,0	29,0
Attracts the process of mastering	14,0	34,0	16,0	27,0
Broadens the mind	32,0	48,0	31,0	37,0

From the materials of the table it follows that the choice of students in the experimental and control groups differs significantly. Moreover, this difference is most significant for the second year of study. The motivation function of the students in the experimental group by the end of training has increased significantly, whereas in the control group the dynamics were not so significant.

4.2 The Study Of The Degree Of Students' Knowledge Assimilation About The Modeling Method

Students performed three test tasks: 1) to distinguish: indicate which of the definitions reflects the essence of the method; 2) to recognize: which of these features are related to information modeling; 3) to choose the correct answer: from the set of named functions, select those that are peculiar to modeling.

The criteria for evaluating the completed tasks were level characteristics:

- level a (low) - if the subject has performed correctly only one of the three tasks;
- level a (medium) – if the subject has completed two of the three tasks correctly;
- level a (high) - if the subject has completed all tasks correctly.

Table 2: Analysis of students' knowledge about the information modeling method, in%

Respondent Assessing parameter	Students in the experimental group		Students in control group	
	1 grade	2 grade	1 grade	2 grade
Level «(*low*)	44,0	12,0	46,0	40,0
Level (*medium*)	46,0	34,0	44,0	50,0
Level (*high*)	10,0	54,0	10,0	10,0
Total:	100,0	100, 0	100,0	100,0

The analysis of the data in the table shows that by the beginning of the study (1 grade), the high level of students' knowledge about information modeling in both groups was insignificant – 10.0% . At the end of the formative experiment in the experimental group the quantitative data changed significantly. Thus, the indicator "a-low level" was characterized by 12.0% (32.0% difference); the indicator "a - medium level" was found in 34.0% of respondents (12.0% difference); the indicator "a - high level" was set for 54.0% of respondents (44.0% difference).

In the control group, the indicator " - low level" decreased, the other two indicators slightly increased: (medium) level - the difference was 6.0% ; a (high) level - the difference was 4.0% . The best results in the experimental group, in our opinion, were promoted by the purposeful use of visual learning and modeling technologies.

4.3 The Degree Of Student Knowledge Assimilation About The Diversity Models' Types And Functions

The study was conducted by testing method. Tests suggested tasks: the formulation of the definitions of the concepts "modeling" and "model" ; on the enumeration of models types; on the listing of modeling functions and models; the determination the sequence of actions in the simulation; the identification of visual learning methods.

The criteria for assessing the results of the tasks were indicators:

- level (low) - high degree of inaccuracies in all tasks;
- level a (medium) - insignificant degree of inaccuracies in all tasks;
- level a (high) - sufficient degree of accuracy in all completed tasks.

Table 3: Analysis of students' knowledge about the diversity models' types and functions, in%

Respondent Assessing parameter	Students in the experimental group		Students in control group	
	1 grade	2 grade	1 grade	2 grade
Level «(*low*)	54,0	11,0	51,0	43,0
Level (*medium*)	40,0	46,0	43,0	41,0
Level (*high*)	6,0	43,0	6,0	16,0
Total:	100,0	100,0	100,0	100,0

Comparison of the data presented in the table allows to conclude that in the experimental group students' knowledge compared with the beginning of the experiment changed not only quantitatively but also qualitatively. For example, if at the beginning of the formative experiment a high degree of inaccuracies in the completed tasks corresponded to 54.0% of respondents, by the end of the experiment the same indicator decreased by 43.0% .

The highest indicator was " (high), amounting to 43.0% compared with the initial 6.0% . In the control group, the dynamics in the students' knowledge turned out to be insignificant. A factor in achieving higher results of the experimental group by the end of training was undoubtedly the purposeful work of students in mastering the modeling method in visual learning.

4.4 The Degree Of Students' Understanding Of the Information Modeling Technology Role In The Structure Of Future Professional Activity

The following tasks were used for the study: 1) to identify the main components of the information modeling technology; 2) to list the approaches to the study of information modeling technology; 4) to identify the main properties of information modeling technology.

The criteria for assessing the results of the tasks were indicators:

- level (low) - high degree of inaccuracies in all tasks;

- level a (medium) - insignificant degree of inaccuracies in all tasks;

- level a (high) - sufficient degree of accuracy in all completed tasks.

Table 4: Analysis of students' understanding of the information modeling technology role in the structure of future professional activity, in%

Respondent Assessing parameter	Students in the experimental group		Students in control group	
	1 grade	2 grade	1 grade	2 grade
Level «(*low*)	57,0	12,0	59,0	38,0
Level (*medium*)	43,0	55,0	41,0	44,0
Level (*high*)	-	33,0	-	18,0
Total:	100,0	100,0	100,0	100,0

Comparison of the table materials reveals a positive trend in the knowledge of students of both groups. However, a sufficient degree of accuracy in all tasks performed in the experimental group was 25.0% higher than in the control.

The average level of the completed tasks, providing for the admissibility of minor inaccuracies, in the experimental group was 55.0% , which is 11.0% higher compared to the control group. As for the results of performing tasks at a high level, in the experimental group was 33.0% , and in the control - only 18.0% .

4.5 Degree Of Mastering Students Knowledge About Information Technology And Skills To Use Them For Information Processing

Students of the experimental and control groups performed the types of test tasks that allowed to establish the degree of students' knowledge of information technologies and skills of their use for processing information

- the level of students' understanding of computer work and fast and accurate application of information technology;

- the level of ownership of performing activitiy, which requires the ability to use a variety of information technologies in the implementation of logical, imaginative and mixed operations;

- the level of ownership of constructive activity, which requires skills related to the modeling of content and its presentation in a graphical version. par

Analysis of the completed tasks results was carried out on the basis of the level characteristics:

- level a (low) - uses with great difficulty;

- level (medium) - owns with some difficulties;

- level a (high) - fluent in skills.

Table 5: Analysis of students' proficiency levels in the use of information technology in performing logical, figurative and mixed operations, in%

Respondent Assessing parameter	Students in the experimental group		Students in control group	
	1 grade	2 grade	1 grade	2 grade
Fluent in skills	32,0	62,0	34,0	36,0
owns with some difficulties	40,0	35,0	41,0	42,0
uses with great difficulty	28,0	3,0	25,0	22,0
Total:	100,0	100,0	100,0	100,0

Comparison of the data in the table shows that the level of students proficiency in the experimental group for all indicators has changed towards improvement. So, if at the beginning of the formative experiment (1st grade), weak knowledge of information technologies when performing various operations was typical of 32.0% of subjects (in control, about the same result), then at the end of the experiment (2nd grade) this indicator changed almost twice for the better and amounted to 62.0% . Similar changes occurred in other indicators, demonstrating that we havechosen the right strategy and tactics of training. In the control group, the changes were insignificant in all three indicators.

4.6 Analysis Of The Students Readiness To Create Various Types Of Models

At the stage of the final experiment, the students' knowledge of the skills for creating three types of models, the most common in subject learning, was studied:

- informative (e.g., the creation of tables, charts, reference notes using signal-symbols);
- structural and logical (e.g., building an algorithm for actions when students perform practical work, the sequence of a phenomenon or process);
- functional-logical (e.g., building a model of the intended didactic process). par

Evaluation of the work performed was carried out according to the following criteria and indicators:

- level (low) - uses skills with great difficulty;
- level (medium) - owns skills with some difficulties;
- level a (high) - fluent in skills.

Table 6: Analysis of students' readiness to create pedagogical models, in %

Respondent Assessing parameter	Students in the experimental group		Students in control group	
	1 grade	2 grade	1 grade	2 grade
Informative models				
Fluent in skill	22,0	71,0	21,0	30,0
Owns skills with some difficulties	34,0	29,0	37,0	44,0
Uses skills with great difficulty	44,0	-	42,0	26,0
Total:	100,0	100,0	100,0	100,0
Structural and logical models				
Fluent in skill	19,0	69,0	21,0	30,0
Owns skills with some difficulties	41,0	25,0	43,0	38,0
Uses skills with great difficulty	40,0	6,0	36,0	32,0
Total:	100,0	100,0	100,0	100,0
Functional models				
Fluent in skills	14,0	59,0	16,0	27,0
Owns skills with some difficulties	20,0	31,0	21,0	26,0
Uses skills with great difficulty	66,0	10,0	63,0	47,0
Total:	100,0	100,0	100,0	100,0

The materials in the table allow us to conclude that the students in the experimental group were more prepared to work on the implementation of modeling. The vast majority of them mastered the necessary skills, as evidenced by quantitative data.

In the control group, although there were changes, they differ significantly from the results in the experimental group.

4.7 Students' Readiness To Use Graphic Visibility In Professional Pedagogical Activity

The study revealed:

- students' knowledge of various graphic tools in subject learning;

- understanding the didactic meaning of graphic visibility in the practice of pedagogical activity (motivating students' activities, maintaining cognitive interest, the possibility of structural presentation of the material and the sequence of its assimilation, the implementation of instruction, consolidation of knowledge and control actions)

- the ability to apply graphic means of visualization in different situations of subject learning (in the process of explaining educational material, checking its mastering, reinforcing students' knowledge, their practical work, in the process of controlling knowledge and skills).

Indicators assessing students' readiness to use graphical visibility in the process of pedagogical activity served the categories "knows," "understands," "knows how."

Table 7: Analysis of students' readiness of to apply graphic visibility in the process of pedagogical activity, in% of the total number

Respondent Assessing parameter	Students in the experimental group		Students in control group	
	1 grade	2 grade	1 grade	2 grade
Knows a variety of graphic visualization tools	19,0	82,0	19,0	29,0
Understands the importance of graphics in learning	25,0	84,0	22,0	40,0
Knows how to use graphic visualization tools in different situations	26,0	79,0	22,0	39,0

Comparison of the data presented in the table shows that by the beginning of the formative experiment, the students' readiness of both groups to use graphical visibility in relation to pedagogical activity was at a rather low level. Conducting a formative experiment, dominated by the visual learning technology, has allowed to achieve good performance in the knowledge and skills of the students in the experimental group.

As for the learning outcomes in the control group, the changes between the beginning and the end of the experiment were insignificant.

5 Conclusion

One of the most important higher education tasks is the quality of preparing students for their upcoming professional activities. In solving this problem, an undoubted role is played by the work to improve the methods and learning technologies. A special place among them is occupied by the information modeling technology.

The study of objects and patterns, no matter how deep they reach, always requires visual reproduction, a certain of their representability. Therefore, instead of the traditional form of visualization, modern science uses imaginative mentally abstractly recreating properties of the object model. The model representation, on the one hand, serves as a means of forming abstract knowledge of the subject, on the other hand, serves as a sensual support of thought as it moves further towards a more in-depth knowledge of the object, towards new abstract knowledge. The mental model helps to interpret the reflection in it of the theoretical knowledge essence in a new concrete practical situation.

Considering the information modeling issue, it should be borne in mind that its use in educational work has a great didactic value, which ensures the accuracy of perception of the studied objects and empirical accuracy.

The study found that any model created in the modeling course contains a certain amount of information. Its mastering by a student takes place at the cognitive, emotional, axiological and behavioral levels.

Considering the mastering information means, we, as one of them, single out the information modeling technology, the use of which in the conditions of students visual learning provides:

- optimization the process of students professional development;
- development of the intellectual properties of the student's personality;
- the development of research methods;
- formation of skills to solve complex, poorly formalized tasks.

The process of mastering students of information modeling technology in learning should be presented in the form of the following educational tasks:

- mastering knowledge: about the features of information flows in the pedagogical field of activity; about promising areas of development and use of information technologies means; about modeling technologies based on electronic educational resources; about educational software;
- mastering skills and abilities: using a computer and computer networks in analytical work with various types of information; information presentation based on its coding in various ways; information modeling implementation in real practice based on information technology; results analysis of the educational process using spreadsheets; processing test control results, etc.

In order the goal and objectives will work, it is necessary to create certain conditions due to which their realization in the learning outcomes would occur. In the formative experiment, we chose as such:

- psychological conditions - the motivation of students' conscious assimilation of information modeling technology;
- pedagogical conditions - intensification and optimization of the educational process through the involvement of visual learning.

The final stage of the study, the quantitative and qualitative data analysis confirmed the our position correctness and revealed a significant change in the students learning outcomes in the experimental group compared to the control.

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