Artículo de investigación

Parameters of modeling the semantic compatibility of educational information

Параметры моделирования смысловой совместимости учебной информации

Parámetros de modelar la compatibilidad semántica de la información educativa

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Abstract

This study explored the process of selecting parameters, which precedes the development of a computer model for analyzing educational texts in terms of the semantic compatibility of the information embedded in them. To analyze the selected set of dichotomies, one should solve several specific applied problems using the methods of mathematical modeling. One of these tasks is the creation of automated tools for identifying some compatibility aspects of information in educational texts. The authors used the dichotomous version of the system approach to identify the pairs of opposites in the

Аннотация

В предлагаемой работе показан процесс отбора параметров, предваряющий разработку компьютерной модели для анализа учебных текстов с точки зрения семантической совместимости, заложенной в них информации. Анализ выделенного множества дихотомий связан с необходимостью решения ряда конкретных прикладных задач на основе методов математического моделирования, одной из которых является создание автоматизированных средств определения некоторых аспектов совместимости учебной

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concept of “educational information,” with subsequent content analysis and interpretation of the characteristics of this multidimensional and complex object. The identified dichotomies were used for substantiating a set of parameters according to the compatibility of educational information entered into computer programs for the analysis and processing of educational texts. The aim was improving the perception and acquisition of scientific knowledge mastered by students. The selected parameters demonstrate the role of the thesaurus and its distribution in the material and consider the unconscious component of the psyche. By analyzing structural characteristics represented in a system of signs, it is possible to use the considered set of indicators for assessing the compatibility of the semantic content of the texts.

Keywords: Semantic compatibility of educational information; parameters of educational information compatibility; modeling; dichotomy; systematic approach; thesaurus measure of an educational text.

текстовой информации. На основе выделенных с помощью дихотомической версии системного подхода пар противоречий понятия "учебная информация", было проанализировано содержание и интерпретация этих характеристик объекта многомерной сложности. Выделенные дихотомии позволяют обосновать набор параметров совместимости учебной информации, закладываемый в компьютерные программы анализа и обработки учебных текстов с целью оптимизации восприятия и усвоения научного знания, подлежащего запоминанию. Отбор параметров показывает значение тезауруса и его распределения в рамках фоносемантического поля для повышения эффективности процесса восприятия и усвоения учебных знаний с учетом неосознаваемого компонента психики. Рассмотренный набор показателей позволяет через анализ структурных характеристик, представленных системой знаков, перейти к анализу совместимости смысловой наполненности текстов.

Ключевые слова: смысловая совместимость учебной информации; параметры совместимости учебной информации; моделирование; дихотомическая версия; системный подход; тезаурусная мера учебного текста.

Resumen

Este estudio exploró el proceso de selección de parámetros, que precede al desarrollo de un modelo informático para analizar textos educativos en términos de compatibilidad semántica de la información incluida en ellos. Para analizar el conjunto seleccionado de dicotomías, uno debe resolver varios problemas específicos aplicados utilizando los métodos de modelado matemático. Una de estas tareas es la creación de herramientas automatizadas para identificar algunos aspectos de compatibilidad de la información en textos educativos. Los autores utilizaron la versión dicotómica del enfoque del sistema para identificar los pares de opuestos en el concepto de "información educativa", con el posterior análisis de contenido e interpretación de las características de este objeto multidimensional y complejo. Las dicotomías identificadas se utilizaron para corroborar un conjunto de parámetros de acuerdo con la compatibilidad de la información educativa ingresada en los programas de computadora para el análisis y procesamiento de textos educativos. El objetivo era mejorar la percepción y la adquisición de conocimiento científico dominado por los estudiantes. Los parámetros seleccionados demuestran el papel del tesauro y su distribución en el material y consideran el componente inconsciente de la psique. Al analizar las características estructurales representadas en un sistema de signos, es posible utilizar el conjunto de indicadores considerado para evaluar la compatibilidad del contenido semántico de los textos.

Palabras clave: Compatibilidad semántica de la información educativa; parámetros de compatibilidad de información educativa; modelado; dicotomía; Acercamiento sistematico; medida del tesauro de un texto educativo.

Introduction

Computer modeling opens up new opportunities for research not only in exact sciences, but also in some humanitarian studies, where the parameters of the studied objects may be hard to formalize. Modeling methods are becoming a powerful tool in various fields of knowledge, including pedagogy, didactics and related fields. The issues of modeling in education and learning have been studied in many specialized and interdisciplinary research papers (Ananishev, 2010; Barakhsanova and Nikiforov, 2018; Dakhin, 2012; Delimova, 2013; Zakharova et al., 2010; Logvinov, 1980; Lodatko, 2010; Morgunov, 2007): the models of educational systems (Ananishev, 2010), modeling for developing tools for independent assessment of students' knowledge (Zakharova et al., 2010), the role of the digital educational environment in the formation of pedagogical competencies (Barakhsanova and Nikiforov, 2018), the issues of pedagogical modeling as an independent field of pedagogical research (Dakhin, 2012), modeling in didactic systems (Delimova, 2013; Logvinov, 1980; Lodatko, 2010; Morgunov, 2007). Such a wide range of research directions is due to multidimensional approaches applied to the educational process as a whole, and to its particular components. This confirms the expediency and necessity of using mathematical methods to analyze nonlinear processes in such multidimensional and complex objects.

In this study we explored such a significant element of the educational process as educational information and the methods of its transmission reflecting the unconscious spectrum of its perception and assimilation. Therefore, in line with the objectives of our research, we analyzed the studies proposing approaches to modeling educational information (Klochkov et al., 2019; Klochkov and Vasilieva, 2011; Klochkov, 1999; Klochkov and Rybakova, 2012; Kudzh and Tsvetkov, 2012; Mayer, 2018; Rybakova et al., 2015). We also analyzed the papers considering the characteristics of the synergistic interaction of the conscious and unconscious components of the psyche in the perception of educational information (Klochkov, 2003; Klochkov and Rybakova, 2012; Kudzh and Tsvetkov, 2012; Mayer, 2018).

As part of this study, we determined indicators of educational information as a modeling object. The analysis of the research publications demonstrated the inconsistency of approaches used to select analytical indicators and modeling methods. This can be explained by the specifics and multidimensional complexity of the formalized object (Hammod, 2003; Kobozeva, 2004; Ohmae, 2005; Posner and McLeod, 1982; Sonesson, 2003; Ugrinovich, 2017; Tsyganov, 2010).

In this paper, we explore the procedure of the pedagogical search for the most common dichotomies. These can be used for selecting effective indicators to ensure the compatibility of educational information. This area still requires further study. In our analysis, from a wide range of dichotomies indicating the multidimensional complexity of the analyzed object (Kamoza et al., 2005; Klochkov and Petrova, 2005; Klochkov and Zaitsev, 2014; Mandelbort, 1976; Ananishev, 2010; Barakhsanova and Nikiforova, 2018; Vasilieva and Krotova, 2014; Dakhin, 2012; Klochkov, 1999; Klochkov and Rybakova, 2012; Uvarov, 1996), we chose dichotomies connected with structural characteristics of the text.

To create a model for analyzing the system of educational texts regarding their compatibility with each other, one should ensure the consistency of the successive levels of the educational material complexity for its subsequent transformation into knowledge. In this article, we aimed to achieve this goal via a sequential enrichment of the thesaurus. The basic concept used in this study is the phonosemantic field, which is understood as a system with connections between its interacting elements—sign structures and semantic content. These connections are difficult to formalize, as they address the semantic aspect of the transmitted knowledge.

The research papers listed above, as well as the preliminary analysis of the existing methods and approaches to modeling educational information, the focus on the integration of the conscious and unconscious in perception and the further transformation of educational information into knowledge (Klochkov et al., 2019) were applied to reach the research goal—creating an element of the model for analyzing the semantic compatibility of educational information based on the dichotomous approach to the analysis of the main research categories, as well as the mathematical apparatus of information theory, mathematical linguistics and computer methods.

Literature review

When analyzing the semantic compatibility of educational information and its effects on the unconscious processes of acquiring and memorizing educational material, one should take into account its field nature. According to A. B. Mikhalyov (1995), the phonosemantic space represents a single structure of semantic and symbolic units grouped around the semantic core. The strength of the connection between them is estimated by comparing the frequency of the keywords (semantic core) and other words used with the core and grouped around it. The strength of internal connections decreases from the semantic center to the periphery of the field, but new connections emerge that are external for the given field: These are connections with other semantic fields and their intersections. Thus, within the systems approach, the phonosemantic field can be considered as a set of elements with connections and relationships between them. Under certain conditions, it can act as an element of another set or its elements can also be considered systems (Apresyan, 1995; Karaulov, 1981; Klochkov and Vasilieva, 2011; Shmelev, 1973).

The structure of the field is formed by peripheral zones, and the one closest to the center is generated by a direct semantic connection with the semantic core. All subsequent zones are based on the connections with the previous layers. A. B. Mikhalyov (1995) applied the "six-step rule" formulated by Yu. N. Karaulov (1981), according to which, the connection between two randomly chosen words can be established through no more than five intermediate words, corresponding to the "six steps." Applying this rule to a phonosemantic field, A. B. Mikhalyov (1995) showed the stability and strength of internal semantic connections. Thus, in analyzing semantic compatibility, one should also study the connectivity between words that occur together in the texts, considering the distance from the sixth step to the center—the word with the highest frequency. In this case, words that have a similar frequency and that most often fall in the radius of the "six steps" (excluding auxiliary words) will have different degrees of semantic compatibility with this central word and each other.

V. A. Moskovich (1969) studied the relationships between semantic elements arranged linearly in speech according to linguistic patterns by analyzing the positional distance of words in sentences, where the distance between them is a characteristic of the logical relation of inclusion (for adjacent words, the distance equals one, for the word that is next but one—this value equals two, etc.). The arithmetic mean of the empirical set of values is the final estimate (1969). Given the regularities identified in the works of Yu. N. Karaulov (1981) and A. B. Mikhalyov (1995), such a distance should be in the range from 1 to 6.

Another way to establish the semantic connection between two words, according to V. A. Moskovich, implies the analysis of their combination with the third word, with which they both or one of them are semantically connected (Moskovich, 1969).

It should be noted that the applicability of these methods to the analysis of key words is determined by the specifics of educational information. This information is in scientific style, and its meaning is significantly different from other types of textual information. The terminological density is a condition for the unambiguous interpretation of the content. In addition, the use of special terminology leads to a high condensation of meaning in words and collocations, and also significantly increases the frequency of their use.

The psychological aspect of understanding a message is another manifestation of the characteristics of the phonosemantic field. Regarding psychological processes of perception, the discrete elements that form the phonosemantic field, according to K. Levin (1980), have different emotional and motivational loads due to positive or negative valencies of signs and their combinations affecting the unconscious part of the psyche. A negative valency leads to psychological rejection, unwillingness to work with information and perceiving it, or in case of positive valency, one is attracted to the material and is interested in working with the text.

Since it is hard to formalize the compatibility of educational information, the modeling algorithm involved the creation of a computer program aimed at building a compatibility model for various types of textual educational information. For this, we developed its functional structure and, next, the model itself in line with its purpose and specifics. One of the algorithm stages implies determining the main groups of indicators in line with the compatibility levels.

Materials and methods

Individual parameters for compatibility of educational information were based on general scientific methods—the theoretical analysis of the complexity measures determined on the basis of various research papers; the system-parametric (Sagatovsky, 1973) and dichotomous versions of the systems approach (Hammod, 2003; Kamoza et al., 2005; Klochkov et al., 2019; Klochkov and Petrova, 2005; Klochkov and Zaitsev, 2013a; Klochkov and Zaitsev, 2013; Klochkov and Rybakova, 2012). These were applied to analyze the parameters selected in order to build the model. We identified a set of pair contradictions within which the analyzed scientific statement or definition was reduced to abstract opposites and next used them in computer applications to analyze certain aspects of educational information and to perform algorithmic analysis of the conceptual and terminological apparatus of the research. Such an approach to selecting the parameters for the analysis automation represents a general scientific method applicable in interdisciplinary research (Klochkov and Zaitsev, 2013; Klochkov, 1999).

Results

To form a set of qualitative and quantitative formalized characteristics, let us use the previously selected group of dichotomies (Klochkov et al., 2019; Klochkov and Rybakova, 2012; Rybakova et al., 2015), indicating the multidimensional complexity of the analyzed object.

To model word processing programs, the most significant parameters for formalization are the parameters which are directly connected with the structure of the texts. Within the dichotomous version of the systems approach, we consider this as a contradiction between *the structured and the unstructured*.

When structuring educational information, its compatibility implies increasing the effectiveness of perception and acquisition and considering the unconscious element of the psyche. The hierarchical principle manifests itself when educational information is transferred in the text form to some medium. For this purpose, one uses specific signs and their combinations of varying complexity, which determines the dichotomous contradiction of *the hierarchical and the linear*.

To describe such a structure, one should use a set of indicators characterizing its different levels—from individual signs to the entire text, which allows one to divide this block of compatibility parameters by their type:

- The indicators of properties and relationships of the first type refer to signs and their groups;
- The indicators of properties and relationships of the second type refer to word forms and their groups;
- The indicators of properties and relationships of the third type are associated with sentences; and
- The indicators of properties and relationships of the fourth type refer to the entire text.

Regarding the analyzed dichotomy, it is worth mentioning the hierarchical stratification of the semantic field structure by identification of the frequency ratios of the words carrying the meaning (Moskovich, 1969). To do this, the author suggests dividing the semantic space into levels, grouping words based on the frequency of their occurrence in the studied extract, and using experimental arithmetic mean values, the variability of which is determined by calculating the mean square and variation coefficient.

Another contradiction, which manifests itself in the structure of textual information used to transfer knowledge, states there are changing and stable characteristics (*the invariable – the variable*). In this context, the knowledge that should be learned is invariable: it is invariant as the author's intention. The semantic component can be defined as variable since it can change when it is transmitted by language means. In modeling, mathematical processing involves the structure at the level of signs, which allows the meaning to be fixated. Therefore, during the preliminary analysis of the texts with educational information at the level of composition and properties, according to the research papers (Klochkov and Vasilieva, 2011; Klochkov, 1999; Klochkov and Rybakova, 2012), we ranked the indicators by the level of invariance. For instance, the indicators of the first level of certainty (composition and properties) were distributed as follows.

1. The number of the groups of signs has the eighth rank of invariance, that is, it can be applied at the following eight levels of the analysis of educational information presented in the text form:

1.1 At the level of individual signs;

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1.2 At the level of sign dyads;
1.3 At the level of sign triads;
1.4 At the level of sign quarts;
1.5 At the level of word forms;
1.6 At the level of dyad phrases;
1.7 At the level of triad phrases; and
1.8 At the level of sentences.

2. The redundancy of sign groups has the seventh rank of invariance. It allows the didactic ordering of texts to be evaluated and the boundaries of the analyzed sample determined by selecting sign groups that are most significant for conveying the meaning. This is because messages contain a certain number of signs and sign groups, without which the meaning of the message can still be fully perceived.
3. The weight of the dominant text also has the seventh rank of invariance regarding the number of levels that it can characterize in terms of prevailing frequencies and sign formations. It is an indicator of the text arrays standardization.
4. A measure of the central tendency determined with an average frequency is used to consider the average statistical error for the entire text (invariance rank = 1).
5. Variability is estimated with an average deviation for the entire text as well (invariance rank is also 1). It reflects the opposite qualitative side of information, defined as its stability, that is, the ability to remain relatively accurate under certain conditions.
6. Dominant sign frequencies are the statistical value of the analysis of the entire text; therefore, it also has the first rank of invariance.
7. The length of the sign group has the second rank as it is used in the analysis of the levels of word forms and sentences.

The above indicators are only associated with the first level of certainty (they describe the parameters of content and properties). A model analysis based only on these indicators will not be complete if one does not consider the indicators of the second level of certainty describing the relationships in the system. In our case, the main relationship will be compatibility, which embodies the dialectical interaction of the connected and the isolated.

The indicators describing this binarity are the indicators of the second level of certainty. In turn, these will be considered as two basic groups at three levels of compatibility in the following sequence.

I. In the first group of compatibility parameters, we will analyze isolation indicators:

– The parameter of individual signs isolation,
– The parameter for dyad signs isolation,
– The parameter of triad signs isolation,
– The parameter of quart signs isolation, and
– The parameter of word forms isolation.

2. The general coefficient of the isolation of the second type of information from the first type with the same set of parameters:

– The parameter of individual signs isolation,
– The parameter for dyad signs isolation,
– The parameter of triad signs isolation,
– The parameter of quart signs isolation, and
– The parameter of word forms isolation.

II. In the second group of compatibility parameters, we will analyze the communication indicators and the correlation of frequencies as follows:

1. The general parameter of linear connection of the first type and the second type of information with such indicators as:

– The parameter of individual signs connection,
– The parameter for dyad signs connection,
– The parameter of triad signs connection,
– The parameter of quart signs connection, and
– The parameter of word forms connection.

2. The general parameter of linear connection of the second type and the first type of information including:

– The parameter of individual signs connection,
– The parameter for dyad signs connection,
– The parameter of triad signs connection,
– The parameter of quart signs connection, and

– The parameter of word forms connection.

3. The overall coefficient of frequency correlation reflecting;

– The coefficient of frequency correlation of individual signs,
– The coefficient of frequency correlation of dyad signs,
– The coefficient of frequency correlation of triad signs,
– The coefficient of frequency correlation of quart signs, and
– The coefficient of frequency correlation of word forms.

The symbolic representation of the antinomy is *the connected—the isolated* was considered by (Klochkov and Vasilieva, 2011) for the category "compatibility" in the following form:

$C_{i,j} = \sum_{j=0}^{n} S_j \sim \sum_{j=0}^{n} O_j$, where:

n is the indicator of the degree of complexity;

j is a variable parameter that may take values from zero to the maximum possible at the present stage of cognition regarding the degree of complexity of the analyzed category;

i is the current indicator whose value depends on the number of ways to solve the contradiction (Barakhsanova et al., 2017; Hammod, 2003;

Harmer, 2001; Kamoza et al., 2005; Klochkov et al., 2019);

∑ is the summation symbol (Klochkov, 1999).
In the transformed form, according to the ternary and dialectical approaches, this formula takes the form:

$\boldsymbol{C_{i,j} = \lambda_{к} + (\sum_{j=0}^{n} S_j >>\equiv<< \sum_{j=0}^{n} O_j)}$, where**:**

λ is the formal indicator of the combination of substantial, attributive, and relational approaches;

n is the indicator of the degree of complexity;
i is the index representing the number of possible ways to deal with contradictions;

j is the index of the maximum identified degree of complexity (Klochkov, 1999).

To determine the direct and inverse relationships of two information arrays fixed in the textual form with a combination of signs, we used linear coefficients of direct and inverse relationships:

$C_{i,j} = \frac{n_i^0}{n_i^j}$,

$C_{j,i} = \frac{n_i^0}{n_j^i}$, where:

$C_{i,j}$ is the coefficient of direct interrelation between *i-th* and *j-th* texts;

$C_{j,i}$ is the coefficient of inverse interrelation between *j-th* and *i-th* texts;

n^0 is the number of similar sign generalities in these texts;

n_i^j is the number of sign generalities in *i-th* text;
n_j^i is the number of sign generalities in *j-th* text (Klochkov, 1999).

When analyzing educational information, one should remember that the academic disciplines of the initial levels ensuring the formation of general education competencies are based on a simpler and less diverse thesaurus. At the same time, direct and reverse relationships in the educational texts within these disciplines can be considered as a linear dependence.

A more academic presentation of scientific knowledge in the disciplines for senior courses is accompanied by a greater complexity of educational information. In this situation we can consider both non-linear direct and reverse relationships. The relationship between two different texts *n* and *m* can be determined through sign generalities *(x*) in the general set (*X*) that occur in these texts with frequencies *n(x)* and *m(x)*, respectively.

The relationship will be calculated as the Cartesian distance between the points of the *N*-dimensional space. A necessary condition is that the dimension of the set of sign units (*X*) is equal to the dimension of the space in which these points are located $|X| = N$.

There are different approaches to the interpretation of "educational information" within various sciences that study this concept. Due to its complexity, it is necessary to use two directions of the analysis of semantic compatibility when it is applied to the object of multidimensional complexity, according to the system-parametric version of V. N. Sagatovsky (37): *the intensional and the extensional*.

The intensional vector includes the study of such

an internal element as semantic compatibility, and the extensional study implies creating an adequate computer model that includes a large set of parameters characterizing both the properties and composition of the textual form of educational information by statistical methods, as well as the compatibility of the component that is the hardest one to formalize—the meaning of the message.

The dichotomy *the insufficient – the excessive* refers to the optimal amount of information in terms of acquiring the meanings (Klochkov and Rybakova, 2012; Barakhsanova et al., 2017).

The structure of a natural language implies that it gives more information in messages than is required for its meaningful perception. According to Shannon's estimates (Shannon, 1963), speech redundancy is approximately 60-70% (these figure is the same for both English and Russian language), i.e., when excessive information is omitted, the meaning of the text is still clear.

In this case, the insufficiency may manifest itself through the fact that if the transmission of information is accompanied with "noise," the reproduction of meanings can be distorted to a certain extent. This is especially true for educational information rich in terminology that implies the formation of new meanings, the expansion of the thesaurus due to new terms and definitions, where an excessive reduction in the amount of information provided can negatively affect the didactic expediency of the created model.

The dichotomy *the optimizable – the non-optimizable* is predetermined by the modeling goals. It implies not only understanding the functioning of the object, but also managing this object as a whole, or its relationships or processes under a set of given conditions. Effective management requires its effectiveness, which in turn is ensured by achieving the optimal balance not for one but for several parameters. However, any optimizable system also has a non-optimizable component since optimality is always conditional to some extent. At the same time, the management itself means that one can influence the parameters of the modeled object, both its input data and output values, analyzing the set of system states during its operation.

Such a dimension of complexity as *the controllable – the uncontrollable* is closely related to the paired contradiction of *the optimizable – the non-optimizable*. In this study, it is implemented by creating a special algorithm of actions and the computer program "Ling Freq" (Rybakova, 2017) to analyze the semantic compatibility of educational information, fixed by means of meanings compression in keywords-terms on paper in the form of educational texts. The general goal of this computer program is to build a compatibility model for various types of textual information.

We considered the following pairs of contradictions as the main ones (*subject – subject*, *object – subject*, *form – content*) in (Klochkova and Rybakova, 2012). The result of this analysis was a system-parametric formula that symbolically describes the optimal relationships in their interaction, taking into account all possible changes in the multidimensional complexity of the studied category:

$$\begin{cases} I_{i,j} = \sum_{j=0}^{n} S_{5,j} \gg \equiv \ll \sum_{j=0}^{n} O_{5,j} \\ I_{i,j} = \sum_{j=0}^{n} S_{5,j} \gg \equiv \ll \sum_{j=0}^{n} S_{5,j} \end{cases}, \text{ where:}$$

I is information,

S is the aggregate subject,

O is the aggregate object, educational information,

n is the indicator of the marginal measure of dichotomous complexity,

i is the variable parameter of the type of solving the contradiction,

j is the variable parameter of the measure of complexity,

$\sum$ is the summation symbol.
$> \equiv <$ is the type of resolving contradictions as the equality of the opposite.

A method for selecting the educational content in one form or another should ensure such quality requirements as accuracy, reliability, and representativeness. Accuracy means that the material corresponds to the actual state of the described object. Reliability implies deviations within the acceptable range that do not distort the meaning of the message. Representativeness means that the material selected can convey the structure and properties of the displayed object in accordance with didactic goals.

It should be said that the relationship between form and content is the most important when modeling the compatibility of educational

information, since it allows one to formalize the element of information that is hardest to formalize—the semantic component. For these purpose, one needs such a parameter as the content coefficient (*C*) or the thesaurus measure, which is determined by the ratio of the amount of information that conveys meaning to its volume. This indicator is based on the concept of a user thesaurus (S_p). This can be explained by the fact that the effectiveness of acquiring the meanings of the transmitted educational information by students depends on its initial set of meanings, the compatibility of which determines how well new, more complex information will be mastered.

The functional relationship between the thesaurus and the amount of semantic information perceived by the subject can be expressed as follows: $Ic=f(S_p)$.

Another information parameter determining its syntactic dimension is defined in a similar manner: the coefficient of informativeness or laconism of the message (*Y*) is the ratio of the amount of syntactic information without the semantic load characterizing the formal structure of the message to the amount of the data determined by the number of bits (signs) in the message. Moreover, the coefficient itself should fall in the range $0<Y<1$. The measure of information laconism determines whether it is possible to optimize its coding stage.

The amount of information increases with decreasing uncertainty. This dependence reveals one more dimension of the complexity of the studied object: *the entropic – the non-entropic*. *Entropy* denotes uncertainty of a system. For the object analyzed in this article, this is the missing information about the system while there is some initial information.

As for the information fixed as an educational text, entropy becomes a statistical measure of uncertainty regarding the distribution of symbolic constructs.

Thus, reduction in the uncertainty means a greater amount of incoming information. A change in this ratio is a manifestation of the dialectical interaction of the poles of the binarity *the entropic – the non-entropic*.

The opposition of *the target – the resultant* (Hammod, 2003) concludes our analysis, since it combines didactic goals with mathematical methods of educational information modeling. It enables the achievement of the initially formed set of goals of varying significance through a system of indicators that are appropriately ranked. In addition, this dichotomy ensures one of the most important qualitative characteristics of educational information—representativeness, that is, the adequacy of the transmitted content to the actual manifestation of objects and phenomena, taking into account the goals set.

Discussion

In order for educational information to be adequately decoded, certain requirements must be met: the logic of the material presented must correspond to the logic of thinking behind it as well as to the logic of the science to which the transmitted information belongs. There should be logical links connecting the various parts of the educational text. At the textbook level, such links are determined by the content of the text, and at the level of a course or university specialty, by the curriculum.

Computer analysis of texts is based on the same logical principle. The condition for formalization is the logical compositional structuring of the information array, and the result is the possibility of applying mathematical operations of data processing to the semantic content of the texts. However, in reality, it can be a bit different. As a rule, the original author's text, apart from a logical structure (e.g., the table of contents), builds information constructs within its sections and chapters according to the author's idea of the sequence of material presentation.

In the information process, the opposite alogical side of the dialectical dichotomy, the logical – the alogical, is also embedded in the unconscious perception and unpacking of meanings. In other words, the very process of understanding the material contains the specified contradiction between the two sides of the psyche that underlie this process. The logic of conscious perception can be analyzed by constructing a graph of logical connections, the vertices of which will be the semantic centers (key words), with a corresponding matrix of logical connections. Using a similar methodology, tested by I. B. Morgunov (2007) for studying the sequence of the academic disciplines in the curriculum, will enable the structuring of educational information by determining the potential number of semantic kernels and estimating the function of the total number of breaks of logical connections for particular text blocks within the disciplines of each cycle. This helps one to determine the optimal sequence for studying the material while

minimizing the number of broken logical connections.

Like any model, the one developed by us with a focus on semantic compatibility is not a full analogue of the modeled phenomenon, but only a reflection of the part of its structure, composition and relationships that were explored in this paper (the ratio of the material to the ideal). This approach is considered to be effective, despite its seeming narrowness. However, its further adjustment to more general models of working with educational information requires further study.

Conclusion

The selected indicators reflect different aspects of educational information. This set was formed on the basis of the selected pairs of complexity dimensions. These parameters cover syntactic, semantic and, to a certain extent, pragmatic aspects of information, which allows one to create a model reflecting all three directions inherent in the modeling process as such—understanding the modeled object, managing it, and predicting its changes.

Thus, integrating the results of the preliminary analysis of such a phenomenon as educational information and its compatibility at the semantic level with the dichotomous approach, we approached the central stage of our research—the creation of the main element of a computer model of educational information—the compatibility model.

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