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Matrix Model of Structure of Biochemistry Curriculum

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Abstract: I have created this model on the basis of theoretical analysis of the information (so far known) in the field of the data mining and analytical-synthetic approaches to problem solving. The analysis in my approach is understood as a scientific method which is based on the decomposition of the whole (the input of universe) to elemental parts. The aim of the analysis is to identify essential and necessary features of the elementary parts of the whole, to identify their nature and patterns. Synthesis is understood as a process of a new joining (neo composition) of two or more elemental parts into the final unit so that the information obtained can lead to a better understanding of relationships between the modeled objects and phenomena and can become the next input universe of the analytical and synthetic modeling.

In connection with the analytical-synthetic modelling it is useful to state some further views on systematic approaches to the creation of specific structures, which is for example represented by the Matrix Model of Structure of Biochemistry Curriculum

Key words: data mining, curricular process, analytical-synthetic modeling, matrix modeling

1. Introduction

In the Matrix Model of Structure of General Chemistry Curriculum which has already been published we reported that the curricular process of chemistry represents the symbiosis of variable forms of curriculum, which Zaskodny (Zaskodny, 2009) defines as an Attained Curriculum (the content of education on the part of educational entities). This curriculum has a form of a learned curriculum which is modified by recipients of education on the basis of their own experience and interests and extracurricular experience and activities.

The knowledge of the curricular process of chemistry, didactic communication of chemistry and of their structure is shown by the analytical-synthetic models, which have already been published.

- Skrabankova J., Prochazka, P. (2006) Analytical-synthetic model of chemistry, Bratislava, Slovak Republic: Didaktis
- Skrabankova J. (2007) Conceptual Curriculum of General Chemistry and Its Analytical Synthetic Model, Bratislava, Slovak Republic: Didaktis
- Skrabankova J. (2007) Conceptual Curricula of Inorganic and Organic Chemistry and Its Analytical Synthetic Models, Bratislava, Slovak Republic: Didaktis
- Skrabankova J. (2007) Conceptual Curriculum of Biochemistry and Its Analytical Synthetic Model,

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Bratislava, Slovak Republic: Didaktis

In these analytical-synthetic models it is possible to find the system conception of high school chemistry as a starting universum of chemistry education with respectation of both needs and possibilities of recipients of this education. Recipients of chemistry education are part of construction and expression of variable forms of Conceptual Curriculum of specific chemistry disciplines (mentioned above), the aim of which is to ensure the transition from Conceptual Curriculum to Attained Curriculum. The Conceptual Curriculum presents scientific system of chemistry.

The logical connection of chosen analytical-synthetic models, which respect the continuity of variable forms of chemistry curriculum from the point of view of methods of modelling of the structural elements of this Conceptual Curriculum, creates more general view of matrix models (e.g., Intended Curriculum).

The inspiration for general conception of analytical-synthetic modelling is the work of authors Tarabek and Zaskodny (Tarabek & Zaskodny, 2002).

2. Content and Methods

Figure 1 represents the general introduction which is needful for basic comprehension of the analytical-synthetic modelling of a cognitive structure.

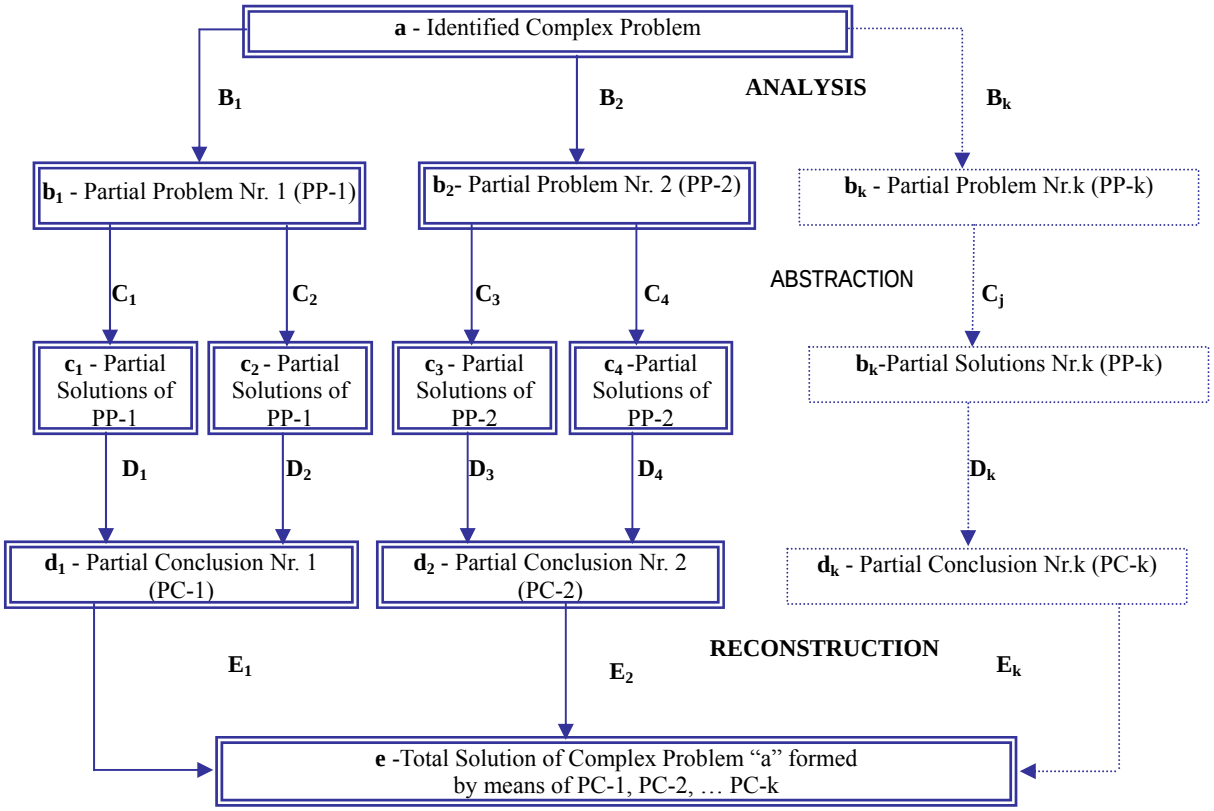

Figure 1 General Introduction Which Is Needful for Basic Comprehension of the Analytical-Synthetic Modelling of A Cognitive Structure

Legend to Figure 1

a … (Identified Complex Problem) — Investigated area of reality, investigated phenomenon

Bk … (Analysis) — Analytical layout within the framework of corresponding knowledge level

bk …(Partial Problems PP-k) — Result of analysis: essential attributes and features of investigated phenomenon
Ck …(Abstraction) - Qualification of abstraction essences within the framework of corresponding knowledge level
ck …(Partial Solutions of PP-k) — Result of abstraction: partial concepts, partial knowledge, various relationships etc.
Dk …(Synthesis) — Synthetic finding of dependences among the results of abstraction within the framework of corresponding knowledge level
dk …(Partial Conclusions PC-k) — Result of synthesis: principle, law, dependence, continuity etc.
Ek …(Intellectual Reconstruction) — Intellectual reconstruction of investigated phenomenon/investigated area of reality
e … (Total Solution of Complex Problem "a") — Result of intellectual reconstruction: analytical-synthetic structure of conceptual knowledge system

This analytical-synthetic models have become the starting point for the matrix model of the structure of general chemistry curriculum:

- From solutions of chemical processes investigation to delimitation of methods of chemical processes description
- From chemistry as natural science to the identification of the subject matter studied by chemistry as concrete natural science
- From the subject of chemistry investigation as concrete natural science to the realization of a switch from the investigation of chemical substances → to the investigation of chemical processes
- Analytical synthetic model of conceptual curriculum of general chemistry
- Analytical synthetic model of conceptual curriculum of biochemistry

Selected structural elements of these models form the basis of the main diagonal of the matrix modeling by Zaskodny (Zaskodny, 2009).

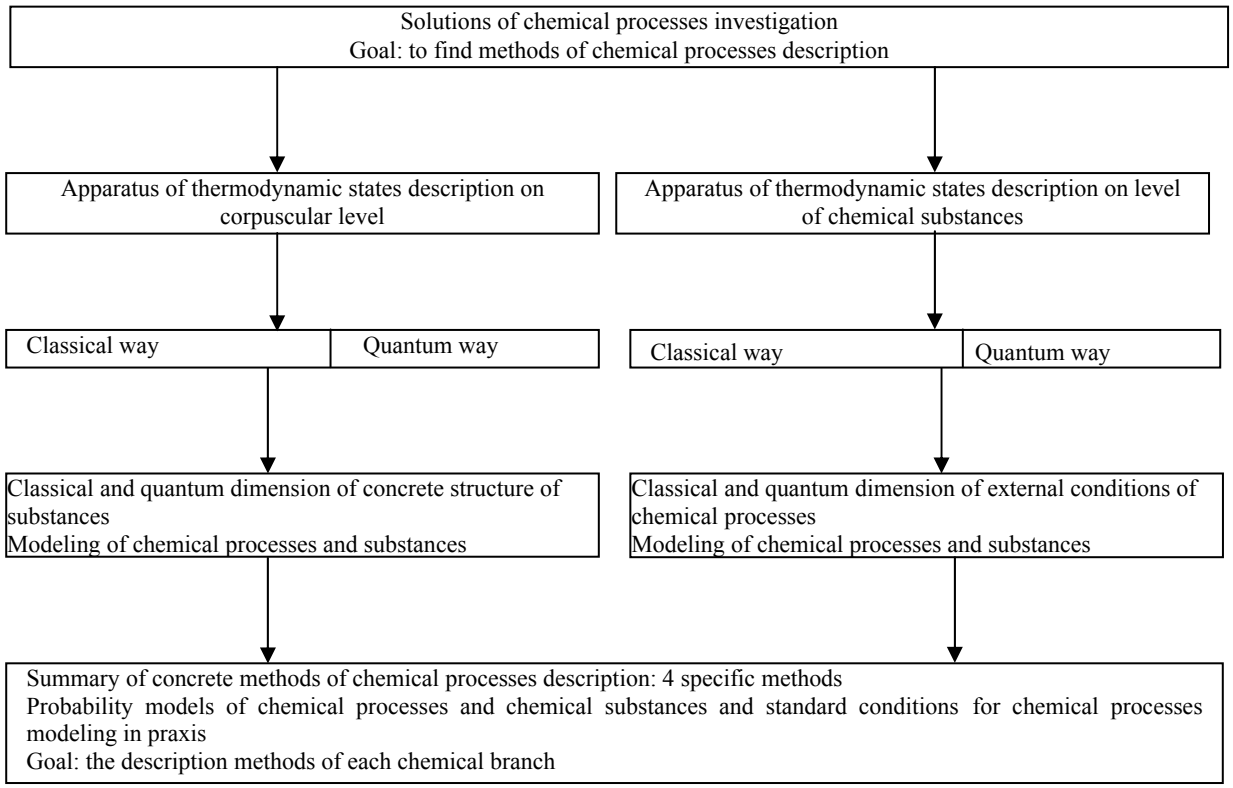

Figure 2 From Solutions of Chemical Processes Investigation to Delimitation of Methods of Chemical Processes Description

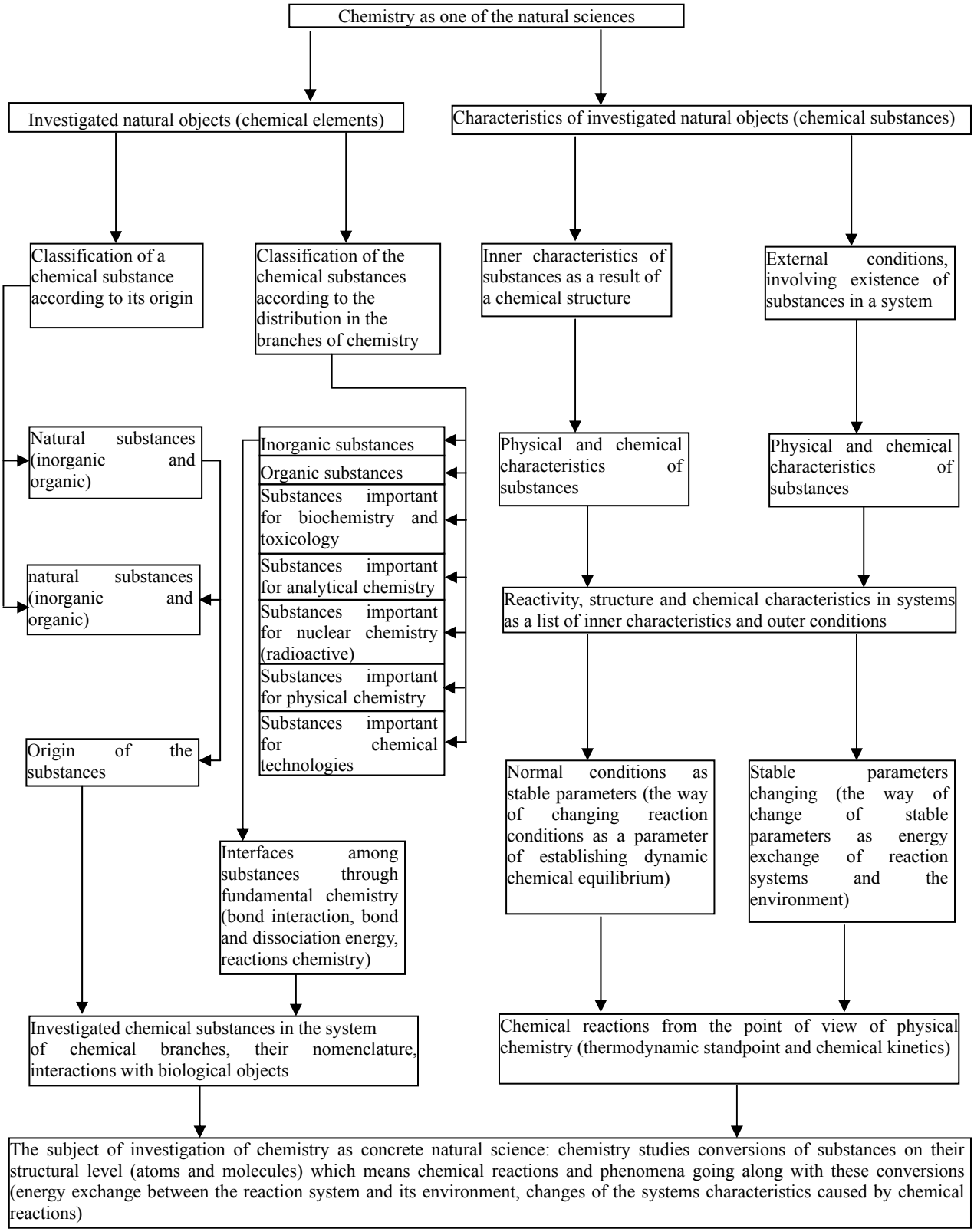

Figure 3 From Chemistry as Natural Science to the Identification of the Subject Matter Studied By Chemistry as Concrete Natural Science

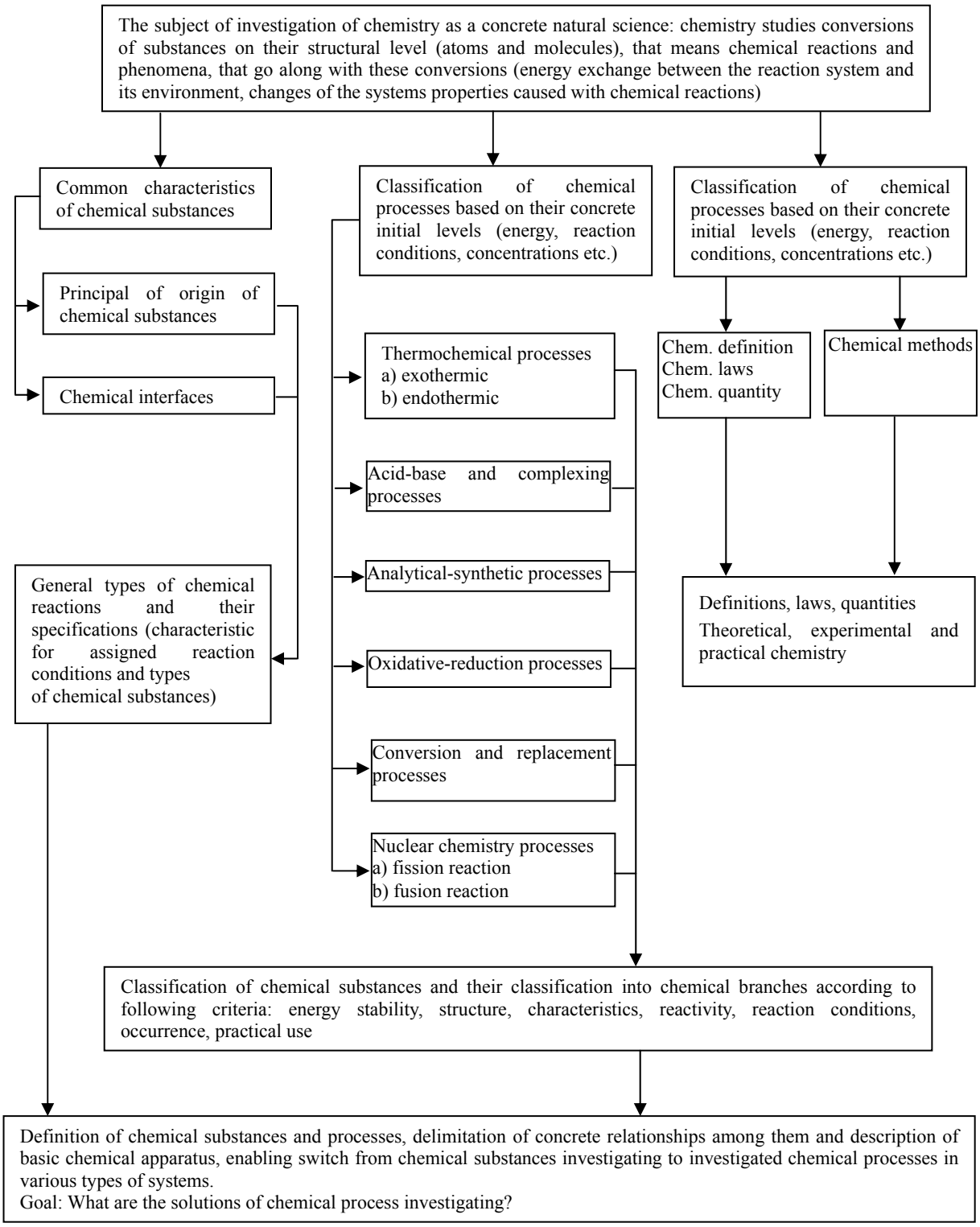

Figure 4 From The Subject of Chemistry Investigation as Concrete Natural Science to the Realization of A Switch from the Investigation of Chemical Substances → To the Investigation of Chemical Processes

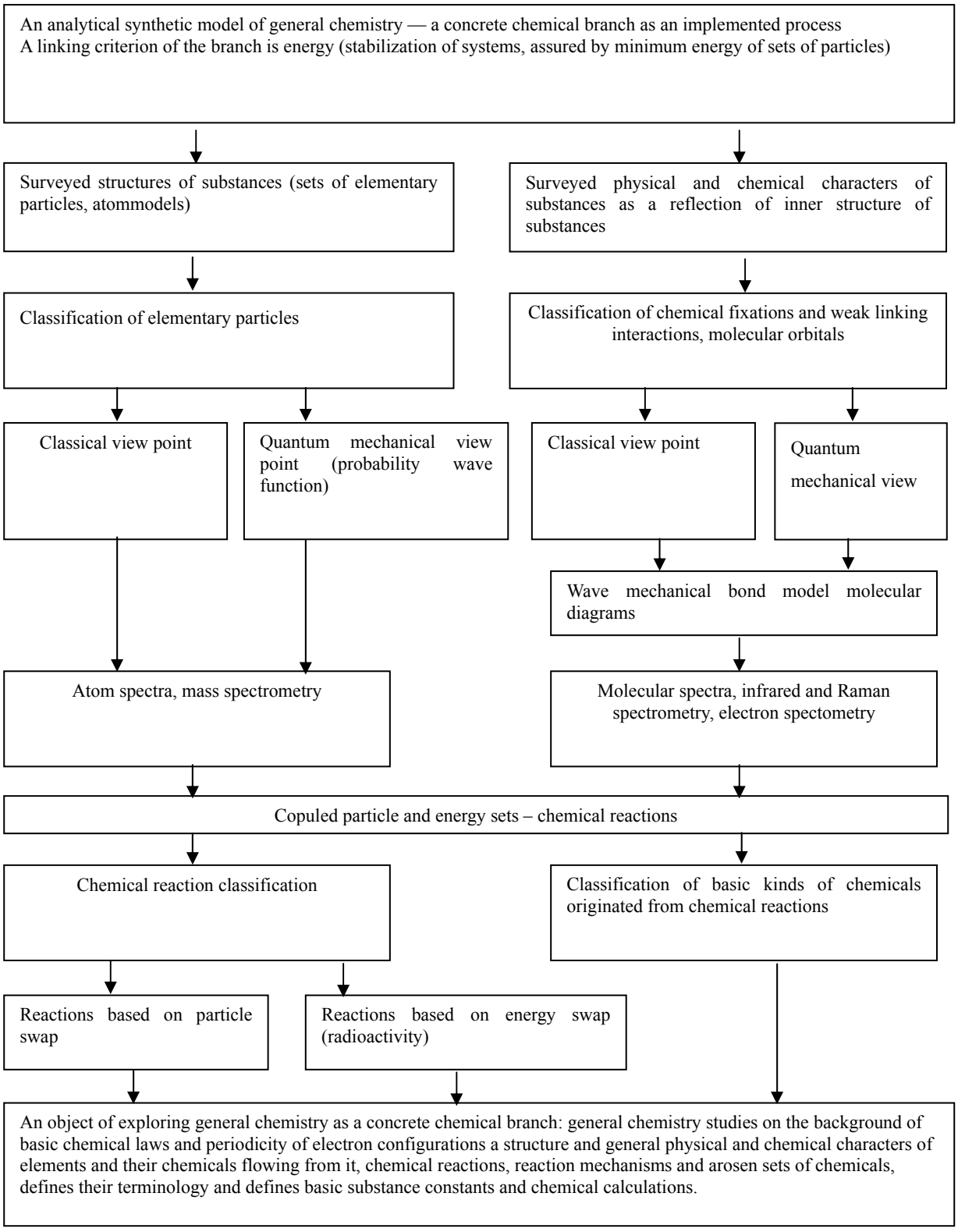

Figure 5 Analytical Synthetic Model of Conceptual Curriculum of General Chemistry

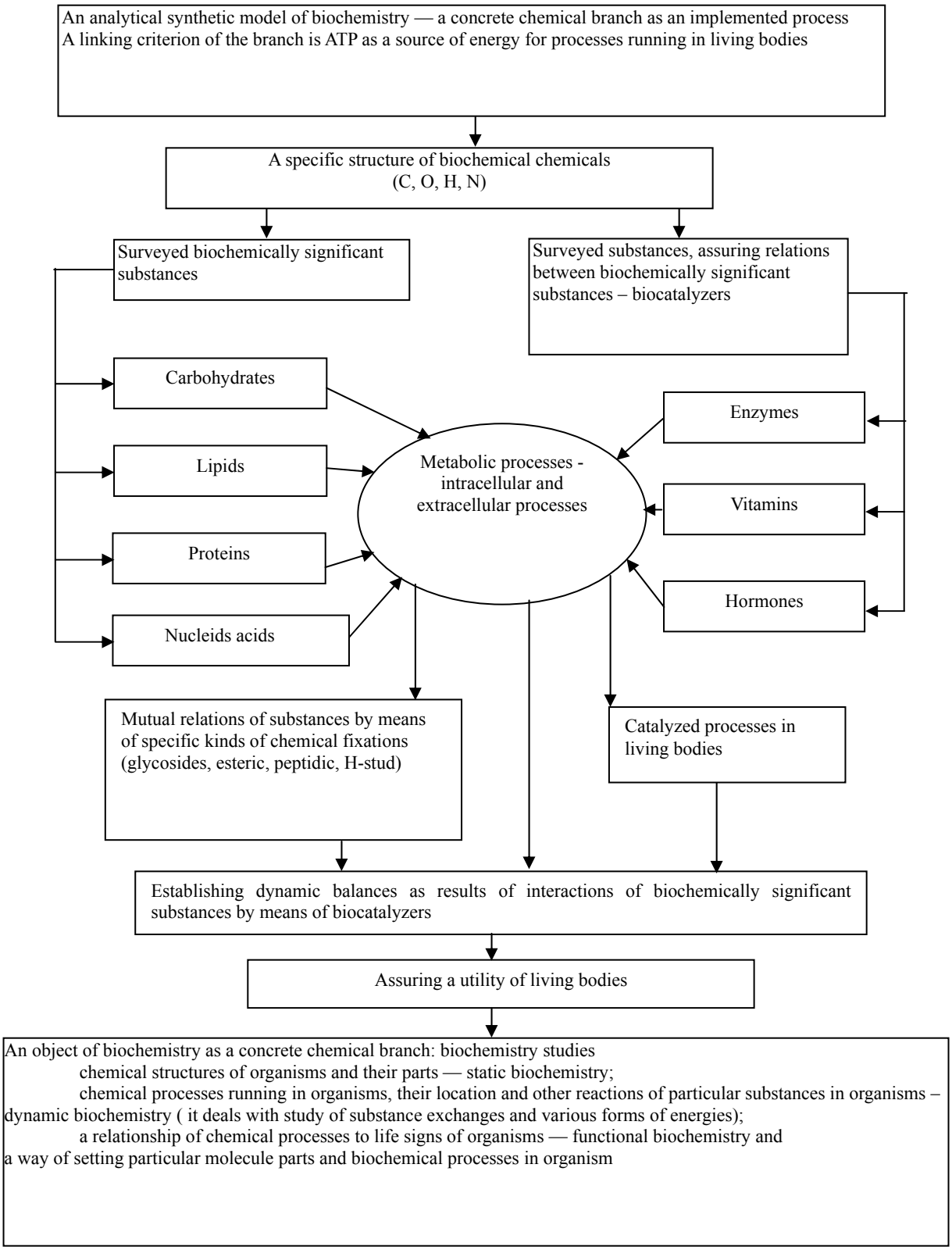

Figure 6 Analytical Synthetic Model of Conceptual Curriculum of Biochemistry

In the following text we work with the above mentioned models and we created the model of a matrix structure of general chemistry curriculum for 1st year of grammar school, which is defined on the one hand as a sequence of successive elements of the main diagonal of the matrix and on the other hand as groups of elements of the matrix forming the knowledge-concept systems from I to V.

The elements of the main diagonal of the matrix form the definition line of this matrix and they are often called units of curriculum (Zaskodny, 2009).

1	=	=	=																	
=	2	=	=		I															
=	=	3	=																	
=	=	=	4	=	=	=	=													
			=	5	+	+	+													
			=	+	6	+	+		II											
			=	+	+	7	=													
			=	+	+	=	8	=												
							=	9	=	=	=	=	=							
								=	10	+	=	=	=							
								=	+	11	=	=	=		III					
								=	=	=	12	+	=							
								=	=	=	+	13	=							
								=	=	=	=	=	14	=	=	=	=			
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													=	+	16	+	=		IV	
													=	+	+	17	=			
													=	=	=	=	18	=	=	=
																	=	19	+	+
															V		=	+	20	+
																	=	+	+	21

Brief description of knowledge-concept systems I, II, III, IV, and V according to Záškodný [1].

3. Results

3.1 Knowledge-concept System I

This knowledge-concept system represents the first part of the basic curriculum on a cognitive level of the 1st year of the four-year grammar school in the Czech Republic.

Identification of the chemistry as concrete science (chemistry studying natural objects - chemical elements and characteristics of natural objects — existence of chemical substances)

Generating elements of the definition line: from the first to the fourth element of the definition line

3.2 Knowledge-concept System II

This knowledge-concept system represents one of the parts of the basic curriculum on the cognitive level of the 1st year of the four-year grammar school in the Czech Republic.

Inclusion of the structure and characteristics of substances in the *chemistry curriculum for grammar schools within the definition of chemistry as practical science* (Normal conditions as stable chemical process parameters, way of changing the reaction conditions as an establishment parameter of a dynamic equilibrium in chemical systems — biochemistry represents classical chemical discipline, which examines the chemical composition of organisms and their parts — static biochemistry, chemical processes occurring in organisms, their localization and other reactions of the individual substances in organisms — dynamic biochemistry and relationship of chemical processes towards life manifestations of organisms — functional biochemistry)

Generating elements of the definition line: from the fourth to the eighth element of the definition line.

3.3 Knowledge-concept System III

The apparatus of the description of chemical composition of organisms and their parts, chemical processes occurring in organisms and relationship of chemical processes to the life manifestations of organisms (Definition of parameters of biochemically important substances as the basis of living matter. Description of the outcome of interactions of biochemically important substances through biocatalysts. Role of specific types of chemical bonds.)

Generating elements of the definition line: from the eighth to the fourteenth element of the definition line.

3.4 Knowledge-concept System IV

Typology of biochemically important substances (carbohydrates, lipids, proteins, nucleic acids, enzymes, hormones, vitamins), typology of metabolic processes (on the intracellular and extracellular levels).

Generating elements of the definition line: from the fourteenth to the eighteenth element of the definition line.

3.5 Knowledge-concept System V

Applications of biochemistry as an area to ensure the functionality of living systems (this knowledge-concept system usually forms the contents of the current chemistry textbooks).

Generating elements of the definition line: from the eighteenth to the twenty-first element of the definition line.

Proposal of elements from No. 1 to No. 8 (units of curriculum) of the main diagonal (the definition line) of the matrix model of chemistry curriculum for 1st year of the grammar school.

(1) The 1st element of the main diagonal

Chemistry as one of the natural sciences exploring natural objects and processes among them.

(2) The 2nd element of the main diagonal

The investigated natural objects and their classification.

Contents (analytical-synthetic model called “From chemistry as natural science to the identification of a subject matter investigated with chemistry as concrete natural science”).

- Classification of substances according to their origin.
- Classification of substances according to their representation in various chemical disciplines, e.g., biochemically important substances.

(3) The 3rd element of the main diagonal

Characteristics of natural objects.

Contents (analytical-synthetic model called "From chemistry as natural science to the identification of a subject matter investigated with chemistry as concrete natural science").

- Independent intrinsic characteristics of substances as a reflection of their structure.
- External conditions affecting the behavior of substances in systems.
- Physical and chemical characteristics of substances.
- Chemical compound in the system of chemical substances.

(4) The 4th element of the main diagonal

Mutual relations of substances through general chemistry.

Contents (analytical-synthetic model called "Model of conceptual curriculum of general chemistry").

- Bonding interactions
- Bond and dissociation energy
- Chemisms (reaction mechanisms) of reactions

(5) The 5th element of the main diagonal

Reactivity, structure and characteristics of materials in systems as a set of intrinsic characteristics and external conditions.

Contents (analytical-synthetic model called "From the subject of chemistry investigation as concrete natural science to the realization of a switch from the investigation of chemical substances → to the investigation of chemical processes").

- Normal conditions as stable parameters of chemical processes.
- The way of changing reaction conditions as a parameter of establishing dynamic chemical equilibrium.
- Change of the values of state variables.
- Way of the change of state variables perceived as an exchange of energy of reaction systems with their surroundings.

(6) The 6th element of the main diagonal

Statically studied chemical substances in the system of chemical disciplines.

Contents (analytical-synthetic model called "From chemistry as natural science to the identification of a subject matter investigated with chemistry as concrete natural science").

- The nomenclature of inorganic substances.
- The nomenclature of organic substances.
- The nomenclature of biochemically important substances.

(7) The 7th element of the main diagonal

Dynamically studied chemical processes.

Contents (analytical-synthetic model called "From starting points of chemical processes investigation to delimitation of methods of chemical processes description").

- Chemical reactions in terms of chemical kinetics.
- Chemical reactions in terms of thermodynamic view.

(8) The 8th element of the main diagonal

Inclusion of chemistry into 1st year of grammar school.

Contents (analytical-synthetic model called "Model of conceptual curriculum of general chemistry").

- The subject of investigation of chemistry as concrete natural science.
- Chemistry studying the changes of substances on the level of their structural particles (atoms and molecules).

- Chemistry studying the chemical reactions and phenomena, which accompany these reactions (exchange of particles in the reaction system, energy exchange between the reacting system and its surroundings, changes in the characteristics of systems caused by chemical reactions).

Applied cognitive structural method — matrix modelling

The corresponding variant form of curriculum — part of knowledge-concept system of Intended Curriculum equivalent to that part of the curriculum of didactic system of chemistry for four-year grammar school in the Czech Republic, which is the basic curriculum for chemistry at the grammar school.

Proposal of elements from No. 9 to No. 21 (units of curriculum) of the main diagonal (the definition line) of a matrix model of biochemistry curriculum for 4th year of the grammar school

The elements of curriculum from No. 9 to No. 21 of the definition line of the matrix model of biochemistry curriculum for 4th year of the four-year grammar school develop (on the matrix model) the knowledge-concept systems III ("The apparatus of a description of chemical composition of organisms and their parts, *chemical processes occurring in organisms and relationship of chemical processes to the life manifestations of organisms*"), IV ("Typology of biochemically important substances and typology of metabolic processes") and V ("Application of biochemistry as an area providing the functionality of living systems").

(9) The 9th element of the main diagonal

The essence of exploring chemistry as concrete science, the subject of investigation.

Contents (analytical-synthetic model called "From the subject of chemistry investigation as concrete natural science to the realization of a switch from the investigation of chemical substances → to the investigation of chemical processes").

- The changes of substances on the level of their structural particles (atoms and molecules)
- Chemical reactions and phenomena that accompany these transformations
- Energy exchange between the reacting system and its surroundings
- Changes in the characteristics of systems caused by chemical reactions

(10) The 10th element of the main diagonal

General types of chemical reactions and their division into specific reactions

Contents (analytical-synthetic model called "From the subject of chemistry investigation as concrete natural science to the realization of a switch from the investigation of chemical substances → to the investigation of chemical processes".

- Principle of chemical substances formation
- Mutual chemical interactions
- Determined reaction conditions
- Types of chemical substances

(11) The 11th element of the main diagonal

Classification of chemical processes on the basis of their specific initial conditions (energy, reaction conditions, concentrations, etc.).

Contents (analytical-synthetic model called "From the subject of chemistry investigation as concrete natural science to the realization of a switch from the investigation of chemical substances → to the investigation of chemical processes").

- Thermochemical processes (endothermic, exothermic)
- Acid-base processes

- Complexing processes
- Analytical- synthetic processes
- Conversion processes and substitution processes
- Processes in the field of nuclear chemistry

(12) The 12th element of the main diagonal

The apparatus of investigation of chemical substances and chemical processes.

Contents (analytical-synthetic model called "From the subject of chemistry investigation as concrete natural science to the realization of a switch from the investigation of chemical substances → to the investigation of chemical processes").

- Chemical terms
- Chemical laws
- Chemical variables
- Chemical methods
- Theoretical, experimental and practical chemistry

(13) The 13th element of the main diagonal

Classification of chemical compounds

Contents (analytical-synthetic model called "From the subject of chemistry investigation as concrete natural science to the realization of a switch from the investigation of chemical substances → to the investigation of chemical processes").

- Representation of chemical compounds in individual chemical disciplines according to the energy stability.
- Representation of chemical compounds in individual chemical disciplines according to the structure.
- Representation of chemical compounds in individual chemical disciplines according to the characteristics.
- Representation of chemical compounds in individual chemical disciplines according to the reactivity.
- Representation of chemical compounds in individual chemical disciplines according to the reaction conditions.
- Representation of chemical compounds in individual chemical disciplines according to the occurrence.
- Representation of chemical compounds in individual chemical disciplines according to the practical use.

(14) The 14th element of the main diagonal

Defining chemical substances and processes

Contents (analytical-synthetic model called "From the subject of chemistry investigation as concrete natural science to the realization of a switch from the investigation of chemical substances → to the investigation of chemical processes").

- Definition of specific relationships between chemical substances and processes.
- Description of basic apparatus of chemistry, enabling the transition from exploration of chemical substances to examined chemical phenomena in various types of systems.

(15) The 15th element of the main diagonal

Biochemistry as a concrete chemical branch (implemented process).

Contents (analytical-synthetic model called *"Analytical synthetic model of conceptual curriculum of biochemistry"*) ATP as a linking criterion of the branch.

- ATP as a source of energy for processes running in living bodies
- A specific composition of biochemical compounds (C, O, H, N)

(16) The 16th element of the main diagonal

Studied biochemically significant substances.

Contents (analytical-synthetic model called "Analytical synthetic model of conceptual curriculum of biochemistry").

- Carbohydrates
- Lipids
- Proteins
- Nucleic acids
- Mutual relations of substances by means of specific kinds of chemical fixations (glycosidic, steric, peptide, H-stud)

(17) The 17th element of the main diagonal

Bio catalyzers, assuring relations between biochemically significant substances.

Contents (analytical-synthetic model called "Analytical synthetic model of conceptual curriculum of biochemistry").

- Enzymes
- Vitamins
- Hormones
- Catalyzed processes in living organisms

(18) The 18th element of the main diagonal

Metabolic processes

Contents (analytical-synthetic model called "Analytical synthetic model of conceptual curriculum of biochemistry").

- Intracellular processes
- Extracellular processes

(19) The 19th element of the main diagonal

Establishing dynamic balance

Contents (analytical-synthetic model called "Analytical synthetic model of conceptual curriculum of biochemistry").

- dynamic balance as a result of interactions of biochemically significant substances by means of bio catalyzers.

(20) The 20th element of the main diagonal

Assuring a functionality of living organisms.

Contents (analytical-synthetic model called "Analytical synthetic model of conceptual curriculum of biochemistry").

(21) The 21st element of the main diagonal

Application of knowledge of general chemistry in the field of biochemistry

Contents (analytical-synthetic model called "Analytical synthetic model of conceptual curriculum of biochemistry").

- Biochemistry as a concrete natural science.
- Static biochemistry - studies chemical composition of organisms and their parts.
- Dynamic biochemistry - studies chemical processes running in organisms, their location and other reactions

of particular substances in organisms (it deals with the study of substance changes and various forms of energies).

- Functional biochemistry — studies the relationship of chemical processes to life manifestation of organisms and arrangement of particular molecule parts and biochemical processes in organism.

Applied cognitive structural method — matrix modelling

The corresponding variant form of curriculum — part of knowledge-concept system of Intended Curriculum equivalent to that part of the curriculum of didactic system of chemistry for a four-year grammar school in the Czech Republic, which is the follow-up curriculum following the basic curriculum for chemistry at the grammar school.

The above method can in principle be used for modelling educational contents of many science disciplines, but also for modelling the humanities disciplines.

4. Discussion and Conclusion

Zaskodny (Zaskodny, 2009) calls the analysis of curriculum and getting hold of curriculum by students a curricular process. Thanks to the acceptance of this term and its modification for educational process of chemistry, it is possible to use the term curricular process of chemistry in the reality of education.

Educational Programs which are obligatory for concrete schools. This chapter offers to examine, possibly compare an attractive modelling of logical structures of subject matter on different levels on the one hand, and a traditional, although innovated strategy of working up and transforming scientific findings on the other hand. The innovation of the educational strategies can be based not only on perfection of the current strategies, but also on quite new integral maps of individual branches, which have been already described abroad. Modeling of the logical structures of sets of branches is becoming a European, even a world trend as well. The trend breaking into the pedagogical sphere, too. The aim of this modelling is to offer a rounded-off structure of information, which can be accepted within the scope of a logical system of science without any necessary simplification.

References

Zaskodny P. (2009). *Kurikulární proces fyziky (s přehledem základů teoretické fyziky)*, Luzern: Algoritmus.

Tarabek P. and Zaskodny P. (2002). *Analytical-Synthetic Modelling of Cognitive Structures*, Vol. 2: *Didactic Communication and Educational Sciences*, Bratislava: Didaktis.

Skrabankova J. (2007). "Conceptual curricula of inorganic and organic chemistry and its analytical-synthetic models", in: P. Tarabek & P. Zaskodny (Eds.), *Educational and Didactic Communication*, Vol. 3, Applications, Bratislava: Didaktis, pp. 62–69.

Skrabankova J. (2007). "Conceptual curriculum of biochemistry and its analytical synthetic model", in: P. Tarabek & P. Zaskodny (Eds.), *Educational and Didactic Communication*, Vol. 3, Applications, Bratislava: Didaktis, pp. 70–75.

Skrabankova J. (2007). "Conceptual curriculum of general chemistry and its analytical-synthetic model", in: P. Tarabek & P. Zaskodny (Ed.), *Educational and Didactic Communication*, Vol. 3, Applications, Bratislava: Didaktis, Vol. 3, pp. 56-61.

Skrabankova J. and Prochazka P. (2006). "Analytical-synthetic model of chemistry", in: P. Tarabek & P. Zaskodny (Eds.), *Educational and Didactic Communication* (Part 1), Bratislava: Didaktis, pp. 112-120.

Tarabek P. and Zaskodny P. (2007). *Educational and Didactic Communication 2007*, Vol. 1: *Theory*, Bratislava: Didaktis.