*International Journal of Arts & Sciences,*
CD-ROM. ISSN: 1944-6934 :: 07(02):573–584 (2014)

# DIDACTIC SUBSTANTIATION FOR THE USE OF CRITICAL THINKING METHODS IN THE CHEMISTRY COURSE OF MEDICAL EDUCATION

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A didactic model – adjusted to specific study situations – was developed and probated in Riga Stradiņš University, Department of Human Physiology and Biochemistry, in order to provide optimum acquisition of chemistry course material by using universal methods for developing critical thinking. By creating a complex of didactic study material and environment for using critical thinking skills, an important correlation was observed, showing that, by improving usage of a single component, an improvement can be observed in others as well. Elementary student critical thinking skills (identification of problems and contradictions, definition of arguments and verification) are obtainable by basing on medical chemistry course material. Methods which develop critical thinking skills (different techniques of information analysis, problem solving, graphic information systemization and dialogue skills) can be effectively used throughout medical chemistry course. As a result – each student gains opportunity to find the most interesting topics as well as suitable learning method, all within a dynamic study environment.

**Keywords:** Didactic methods, Critical thinking.

## Introduction

The developed didactic model is intended to ensure mastering of study material in medical chemistry course by using critical thinking development methods. The didactic model also includes successive steps for mastering medical chemistry, forms of work organization and techniques, realization of which using critical thinking development methods, can positively affect acquisition of study material. Student grades are determined by qualitative criteria for mastering course material (theoretical knowledge, experimentation skills, problem solving skills) and corresponding critical thinking levels which can be determined by final examination.

Critical thinking development methods used in medical chemistry course are: different methods of information analysis, problem solving, different methods of graphic information systemization and dialogue and self-evaluation. Obtained elementary critical thinking skills are: problem identification, search for evidence, argumentation, identification of contradictions and imperfections based on medical chemistry course.

Also of significant importance is organizational experience which can be gained by planning one's own time. E.g. weekly tasks can be planned more effectively when the plan of the whole semester is already known. Weekly formative tests allow students and lecturers to analyze effectiveness of own work methods. Freely available multiple information sources - at the same time - give opportunity to compare several examples for the same fact layout thus allowing everyone to form a more personal view.

Students must gradually reach a conclusion that only they are responsible for own grades and that they must find ways to use the lecturers potential to its fullest rather than the other way around. At the end of each period of time (week, month, semester, year) students must look back to their achievements and determine, whether consistency and success were reached.

Effectiveness of didactic model depends on suitability of each individual study method and approach for a given study topic and situation. Study method is a system of didactic collaboration between students and lecturer which is necessary within a certain didactic principle or pedagogic approach in order to accomplish and reach study, education and development tasks and goals.

Functional level of method determines its task, provided the necessary goal is reached. Objective level of method displays ways how to practically realize functional level tasks, i.e. organizational work, informative and situative actions, management, control and stimulation.

Method cannot be something external in relation to material. Method must provide organization of study material which is more effective. From student's perspective, method must ensure effective focus on material which would be purposefully usable with minimal effort and usage of time (Dewey, 1916).

Choice of didactic instruments varies depending on topic and student's work potential. Given material anticipates good preparation on student's part since profession of medic demands universal knowledge.

## Literature Review

Mastering of medical chemistry course is based on systemicity, humane-pedagogic approach and principle of information research thus developing student self-dependence as key element of self-determined studies.

Systemic approach allows using critical thinking development strategies and methods by using them as a whole, complete system which functions within critical selection of information, analysis, reflexion and self-evaluation. System is an integrated unit, which should not be perceived as sum of its elements even though during cognition process connection between elements is understood gradually.

Ordered cognition of the world and successive action corresponds with the way humans think (Broks, 2000).

If appropriate conditions are created students integrate the information obtained in different fields into single complete unit, e.g. theoretic information is illustrated with common examples and/or they coincide with information obtained in other courses. Systemic approach ensures feedback between students and lecturers as well as provides information regarding their motivation and achievements.

Humane-pedagogy centers around a person as an active being equipped with will and senses within all aspects of life - and this integrity is not limited to intellect alone. Different directions of humane-pedagogy are all based on philosophy of modern humanitarian science by Wilhelm Diltey. Diltey separated it from normative sciences (ethics, theology) and natural sciences (by Gudjons, 2012).

The approach of humane-pedagogy towards education process is more person-oriented and of individual character which is important when developing student's critical thinking skills as a personal quality. Humane-pedagogy is based on equality and partnership between lecturers and students thus promoting student's active involvement in study process. Active and motivated student position indicates a certain level of personal maturity. During the first semester, however, majority of students only begin to realize and understand how study process is organized. By accenting student's self-dependence as a key element to self-determined study process a basis for successive goals is created - mastering and developing ones profession and lifelong learning.

Based on mentioned principles, a didactic model was formed which suits the notion of effective study process in given situation - in this case beginning of the study process.

The more precise this model develops study process components - contents, properties, functions and integrity, the better can it be realized practically (Žogla, 2001).

For mastering medical chemistry as the most appropriate are considered cognitive, critically constructive and pragmatic ideas, with addition of basic ideas of other models and - of course - didactics of chemistry. The developed didactic model is intended for ensuring mastering of study material in medical chemistry course by using critical thinking development methods.

A constructive approach created upon basis of humane-pedagogy grounds justifies several didactic models. Constructive didactics accent and value previous experience for constructing new experience. It is based on the notion that "humans are active and realize their lives in action, purposefully search for new knowledge while generating new experience in their lives" (von Glasersfeld, 1991).

Many teachers often ground on principles of constructivism quite intuitively and unconsciously. "Constructivism does not claim to have made earth-shaking inventions in the area of education; it merely claims to provide a solid conceptual basis for some of the things that, until now, inspired teachers had to do without theoretical foundation". His comments remind us, as well, that constructivism is more than a theory of learning. It is a set of beliefs that can be translated into principles to guide our actions (von Glasersfeld, 1995).

Principle of constructivism is mentioned as one of the most important in research of human mind by J. Bruner which is based on approach of cultural science. J. Bruner draws accents the idea that reality is constructed rather than exists on its own. At the same time he highlights that "construction of reality" is characteristic to a given culture and is created using tools available in certain culture (Bruner, 1996). Another approach of J. Bruner - informative - is based on research of coding, storing and processing of perceptible information.

There are a variety of perspectives and emphases within cognitive psychology that are currently impacting educators' thinking about how to improve the teaching/learning process. The Information Processing approach focuses on the study of the structure and function of mental processing within specific contexts, environments, or ecologies. Benjamin Bloom and his colleagues developed the Taxonomy of the Cognitive Domain as a way to classify the variety of educational objectives related to what and how we know. Researchers in the area of intelligence study how human beings learn from experience, reason well, remember important information, and adapt to the environment. Jean Piaget's theory of cognitive development describes the process and stages by which human beings develop the capacity to engage in abstract symbolic thought, one of the distinguishing features of human activity. Piaget's theory is often contrasted with the views of Jerome Bruner and Lev Vygotsky.

Bruner advised to teach more effectively by structuring knowledge based on the spiral curriculum which, as it develops, should revisit this basic ideas repeatedly, building upon them until the student has grasped the full formal apparatus that goes with them. It was based on child's ability to grasp basic knowledge early on, which then is repeated in older grades but in a more complex level (Bruner, 2006).

Cognitive didactic model is based on teaching (knowledge transfer and inheritance). Its goal is to research technique and strategy used in solving problems, reasoning and decision making by linking it with human intellect (Halpern 1996). Learning as a cognitive process is also present in Benjamin Bloom's taxonomy of didactic goals. (Bloom, 1956)

Knowledge acquisition and situation analysis which transforms into action occurs through revelation during study process and vice versa - analysis of practical actions creates intellectual and mental values.

Based on cognitions by Vygotsky, highest human mental functions are constantly accompanied by actions: acting and thinking is linked together and mutually dependent. Verbalized action at a certain point of development gains significance in social behavior system as indicator of socialization. Actions of adults are structured and follow analytic self-reflexion as opposed to child's syncretism.

"Psychological means develop socially rather than individually and their purpose is to guide and influence human behavior. Examples of psychological means are: language, counting systems, memory exercise techniques, works of art, writing, diagrams, schemes, maps, blueprints, symbol systems" (Vygotsky, 2002).

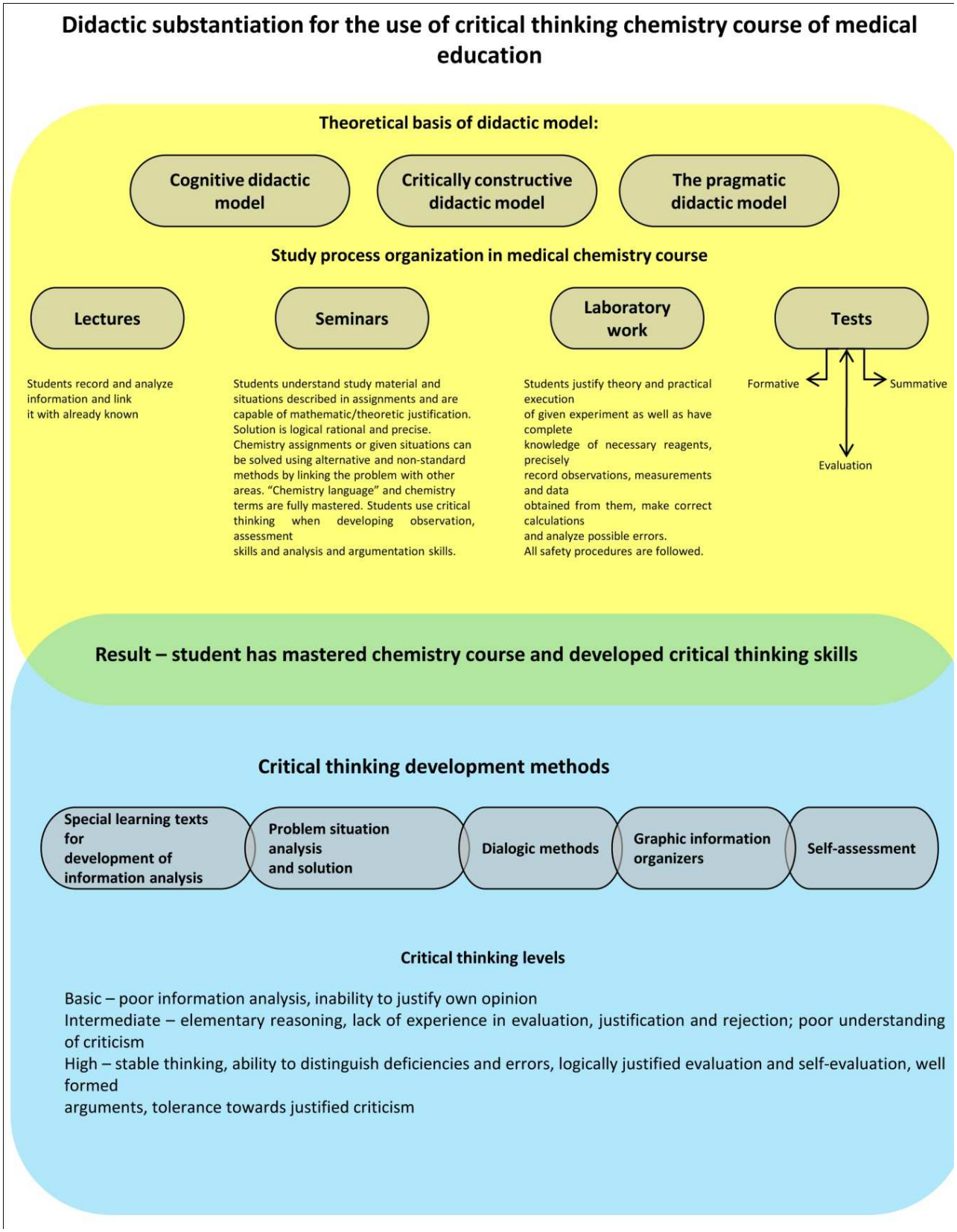


**Figure 1.** Theoretic justification of didactic model.

Actions have two results - material and mental. Mental results include new or improved knowledge and skills as well as improved ability to learn. During mental and practical action knowledge gets regrouped based on its quality and suitability for task in hand: part of knowledge gets actualized and becomes as basic knowledge for current task. Lecturers have to respect individual ways how students gain knowledge by allowing everyone to learn in one's own personal manner since everyone explores the world differently.

It is impossible to master chemistry without laboratory work and demonstrations which fortifies what was learned theoretically and created a link between new and already known as well as joins all three physiological ways of perception - visual, audible and kinesthetic (Smith, 2000 ).

Together with general didactic principles, differences characteristic to a more narrow scope of didactics in chemistry were abided. Such differences can be observed in display of study material, nuances and examples created specifically for students of medicine. By highlighting practical components of study material, the - common to universities - sequence of presentation was somewhat violated: structure of molecules, energetic justification and kinetics. This offset from common sequence of presentation is caused by the constant need to justify necessity of chemistry in medic's education since - based on clinic examples - students are motivated to understand causes and regularities. In other words - priorities are changed to answer why medics should know something rather than how it works.

Professional standards of medic's profession anticipate very precise and specific competences and operations for specialists in field of medicine therefore future medics are oriented towards practical study result. This condition demands use of elements from pragmatically practical didactic model.

J. Piaget characterizes knowledge as a process. To know - means to act based on knowledge both when action is theoretical or practical (Piaget, 2002).

Pragmatically didactic model is directed towards current rather than future needs and allows gaining necessary knowledge in order to competently act in standard situations. Informative material is selected based on principles of efficiency to ensure theoretic ground for practical action.

J. Dewey notes that new knowledge and skills are gained based on cognitive process which is already mastered. Therefore learning is dependent on development rather than teaching. It is important to remember that notion of learning by doing is also important. As a result experience is gained psychological justification of which is used in pedagogy of action (Dewey, 1916).

## Critical Thinking Development Methods

Within the many critical thinking development methods described in literature, the ones which are universal and suitable for any discipline are very rare. Most of them are designed for humanitarian sciences. Methods, psychologically - pedagogical justification of which highlight context-independent development of critical thinking, were used as starting point. Awareness that students can critically evaluate information within familiar scope but lacking facts is unable to evaluate within another is a level of criticism itself since understanding that information is insufficient displays self-critical approach towards solving problems.

For this purpose a material oriented towards self-dependent learning was developed - "General chemistry". Interactive work methods were also approbated as promoting factors for developing self-organization and critical thinking skills within study process. Since study process anticipates the use of other sources of information, the developed study material performs the function of "work material". The main emphasis is placed on effective use of universal study methods (both didactic and experimental) justified with understandable examples rather than deep understanding of basics of chemistry. E.g. thermodynamic regularities are learned by successively moving from general regularities towards regularities of specific examples and vice versa - by generalizing specific examples until fundamental regularities are obtained. As a result, their previous experience gains theoretic justification since future doctor should not mention the trivial "burning of calories"but rather should have understanding that every process in organism is performed on a molecular level with use or generation of energy.

**Special Educational Texts Adapted for Critical Thinking Development in Three-Phase Practical Lesson Model: Initiation, Realization and Reflexion**

Upon starting studies, high school graduates have very different experience of obtaining and analyzing information. Very often students are unable to understand whether one assumption results from another or is it a development of already known, an illustration or a contradiction. For this purpose specialized study materials were created by adopting them for three-phase model of critical thinking development: initiation, realization and reflexion.

Initiation (systematization of existing experience) phase is when students actualize existing knowledge regarding study subject, recognize missing information and include research elements into a chain of logical reasoning and sets own individual goals for research and solution of a given problem.

Realization (realization of individual goals) phase is when students evaluate new material, form a personal opinion of it and evaluate justification and arguments necessary for reasoning about the given problem.

Reflexion (formation of personal position) phase is when students completely understand the problem at hand and are able to analyze own thoughts, causes for given phenomenon and predict a result. During this phase students also draw conclusions regarding performed work and analyze personal mistakes and effort.

Critical reading is analysis of text while evaluating described ideas and assumptions with their consequences and spotting logical contradictions as well as ability to skillfully form questions.

R. Paul qualifies reading as macro-skill since during reading many micro-skills are coordinated together (Paul, 1990).

Macro-skills are processes which are involved in thinking and arrangement of separate elementary skills within expanded sequence of thoughts in order to avoid the elements being fragmented and unrelated (Fisher, 2005).

Broad and easily obtainable information which can be used for studies as well as within any other field broadens the concept of "text". It can be a material in mass media as well as scientific literature or audio or video material of a lecturer which can be easily perceived by reading, listening or watching. All of these variants of text can be used for critical thinking development as they provide the opportunity to:

- understand causes and effects;
- grasp new ideas and gain knowledge within context of existing knowledge;
- filter and reject unnecessary or ambiguous information;
- identify regularities between fragments of information
- analyze erroneous information;
- avoid making categorical and biased statements;
- spot stereotypes which may lead to incorrect conclusions;
- avoid prejudice;
- differentiate justified facts from assumptions and authoritarian opinion;
- question inconsistency in logical justification;
- separate relevant from irrelevant and highlight the most important.

Many professional education programs depend on information present in web which is not adaptable for specific study topic thus impeding self-determined studies. It is lecturer's task to promote optimal conditions for self-directed learning.

Overcoming potential obstacles and freeing students from unnecessary consumption of time for filtering information is possible by incorporating regularities of general chemical processes which are illustrated with examples of clinical cases and special cases(which can be used for illustrating study material) into study material(Bulik&Burdine&Shokar, 2007).

Students must find a way to search and analyze popular yet erroneous opinions which have often become parts of our daily lives. For future medics it is unacceptable to ignore such opinions. With the help of trivial examples (analysis of text in advertisements), it is possible to create an effect of maximum

contrast between correct information and it's incorrect interpretation. By reading such texts, students train themselves to use existing and new methods of information analysis: record facts, evaluate whether information is a development, illustration or contradiction to what is already known.

Methods of read information analysis SQ3R (Halpern, 1996; Huitt, 1997) and SQ4R are based on cognitive psychology. Due to importance of reflexion, the fourth R was added by Huitt (Survey, Question, Read, Recite, Reflect, and Review).

Aside from understanding text itself of high importance in natural sciences is understanding of quantitative regularities which can be displayed as graphs, schemes, tables and other methods of information visualization. A part of students lack experience in perception of schematic information and data interpretation and vice versa - displaying broad information in a schematic manner and using quantitative data for proving a hypothesis. While performing laboratory and practical work during semester, missing knowledge is actualized and students begin to understand that data obtained experimentally, text fragments and personal experience can all be used as proof. Any argumentation consists of three elements: statement, argument and proof. Evidence, in turn, grounds statements and justification which are key elements of argumentation.

**Development of Reflexion by Encouraging Dialogue**

Dialogue is one of the instruments of critical thinking which at the same time functions as one of critical thinking development methods. Students are encouraged to participate in a dialogue by asking questions and analyzing answers. Such analysis is considered as reflexion which allows every student to follow the course of learning. In verbal form it is possible not only to express one's own personal or intellectual position but also reflect upon question at hand.

The 35 cognitive strategies formulated by R. Paul also include development of discussion skills which allow expression of one's beliefs, opinions and theories. Dialogue is a mean for comparing interpretations (Paul, 1990).

Ability to conduct a constructive dialogue, mutual exchange of thoughts and discussions with lecturer can be exercised by developing speaking and listening skills(Huitt, 1997).

Ability to ask well-thought questions is just as important as ability to answer. Remembering and understanding information is facilitated when students have developed this skill and its use has become spontaneous.

Lecturer can stimulate self-dependent thinking, encourage students to participate in discussions and promote active listening and thinking by:

- avoiding excessive instructing and controlling and - when necessary - guide discussions by discrete and suggestive questions and explanations;
- using understandable vocabulary and highlighting the fact that current topic is already familiar within another context;
- identifying contradictions of rephrasing already said and stimulating students to give alternative answers and explanations;
- spontaneously reacting to unplanned processes and using them as reinforcingfactors and illustrations;
- adapting several discussion speeds in order for all students to be able to participate in discussions;
- using different types of questions and getting different types of answers - from fact reproduction to analysis, synthesis and generalization.

In accordance with cognitive behavior Benjamin Bloom systematized questions and guided students towards self-dependent reflexion. The types of questions are: comparative, interpretative, questions regarding use, analytic, synthetic and evaluative questions (Bloom, 1956).

The goal of a question is to urge students to follow the course of comprehension of read information by dividing information in reasonable fragments which can be placed within familiar context.

Readiness to reason is promoted by healthy attitude towards discussions. People often confuse discussions with disputes. Discussions are justification of opinion whereas dispute can be considered as verbal fight. One of characteristics of critical thinker is readiness to examine ideas of others. "Openness to examination and criticism does not mean that one cannot have personal opinion or belief but rather that person willingly:

- makes decisions based on evidence and its evaluation;
- tests own ideas and decisions;
- is prepared to be examined by others;
- acknowledges the possibility that he/she is wrong" (Fisher, 2005).

During study process very important is mutual communication. During seminaries students participate in dialogues and correct and complement each other. By not agreeing and opposing to others, majority or even authoritative opinions and braking traditions, students learn to make personal decisions. Argumentation skills are improved as well as skill to analyze and correct own opinions in cases opponents provide adequate evidence. By working in groups and generating new ideas for solving a given problem, students develop individual skills, discover own resources and use them for finding combined solution.

**Analysis of Problem-Situations and Problem Solving**

Critically thinking person finds solution to a problem and justifies this solution with valid arguments. Every argument, in turn, is justified with empirically obtained evidence, e.g. laboratory work result data and its statistic processing and theoretic justification are the separate steps of proving the hypothesis.

As Carl Popper said, science is nothing but problem identification and solution with critical attitude towards own solution (Popper, 2005).

Methodic rules of Descartes can be considered as didactic steps of problem solving. Descartes considered as necessary to doubt everything that exists. This doubt is not a belief that nothing can be truly explored but rather a way of finding a reliable method of cognition. In this regard the first fundamental methodic rule demands refusing everything that is cannotunmistakably be considered true. Cognition can be done only by thinking. The second fundamental rule demands dividing every problem into as many parts as necessary to find a solution. This is the principle of analysis - problem can be solved more easily if it is divided into several sub-problems. The third rule states that a system can be introduced in structure of cognition starting from simplest cognition to more complex ones. That is a fundamental rule of deduction - creation of science based on few fundamental rules which are used to logically derive many more specific rules. In the last fundamental rule, Descartes demands classification of - when at all possible - all cognitions (Descartes, 1978).

Creation of problem-situations is effective only in cases when there is a logical connection between already known material and if opposition of new and existing material makes one wonder and creates a desire to explore further without confining oneself to already existing knowledge.

Problem solving as critical thinking development method can be realized in many forms but the most effective - both for students and lecturers - in David Kloosteropinion is in written form. Written form allows lecturer to follow the thinking process. The person writing, on the other hand, is able to use his/hers whole knowledge. A well formed written problem solution should contain the search for solution as well as final answer. Students as well as pupils writing is the most difficult part of study process (Klooster, 2001).

J. Dewey highlights „sense of burden" and psychological experience when coming across a problem. In order to solve the problem, J. Dewey suggests a procedure consisting of "five steps:

a) Problem description and analysis;
b) Generation and elaboration of possible solutions;
c) Evaluation of possible solutions;
d) Consensus decision;
e) Implementation of the solution chosen" (Dewey, 1916).

Problem-situation not always should be prepared. Any information which attracts attention in real life with its ambiguous nature can be interpreted as problem-situation and problem-task. Students are usually very responsive when solving problem-situations created by themselves. The task of a lecturer is to actualize existing knowledge and guide student's solution process within a certain study context. Sense of burden is a significant stimulus for thinking, though not every burden invokes thinking. In some cases it might slow down or suppress thinking process. The sense of burden in some way must resemble an already experienced situation in a way that solution seems accessible. It is therefore that results and solution process allow evaluation of student's critical thinking level.

Huitt claims that people who successfully solve problems are both creative as well as consistent in their approach. People who are able to recognize and solve problems as well as explore different solution variants by using critical thinking strategies and also guide cognition process are successful in work and life in general (Huitt, 1998).

Creation of problem-tasks demands a lot of work since they must be connected with real life. It is necessary to distinguish real, imagined and artificial problems.

The following questions help identification of regularities, generation of hypothesis and it's justification by using own experience:

Is the question at hand actually a problem? Does the question at hand originates from real situations or from personal experience? Is it an assumption which can be considered as a problem only within the scope of current topic? Does discussion of this problem introduces a will to experimentally test it outside school (Dewey, 1916)?

Interactive methods used when working with information facilitates understanding due to more active involvement not only in obtaining information but also in using it without worrying about possibly incorrect assumptions while relying on help from lecturers and colleagues. At the same time it increases the motivation to get involved into finding new problems by justifying own position and listening to opinions of others and mutually cooperating.

**Information Analysis, Graphic Information Organizers**

In order for the important transition from perceived to understood, it is necessary to have some new thinking instrument. Observations must be included into well understandable system of symbols in order for them to become explainable with scientific terms (Cassirer, 1997).

The next - already more complicated level of information analysis - are graphic information systemizers. Their creation demands a higher level of reflexion than text analysis. By working with reduced amount of contact-hours, graphic systemizers become a support for organizing self-directed study process. Use of graphic information organizers help visualizing already known and add new information and practice developing argumentation skills.

Within medical chemistry course visual information - possibly - is of more importance than in other fields. Not only schematic representation of facts is of great significance, but also representation of quantitative regularities in tables, graphs and schemes. Students must learn interpreting visual information correctly, e.g. read graphs and vice versa - visualize obtained results in accordance with regularities of corresponding chemical process. Until now students convincingly remember existing schemes literally therefore during first semester an emphasis must be placed on self-dependent creation, examination and mutual comparison of graphs, schemes within practical exercises It is a vital necessity since the following course of biochemistry cannot be mastered without being able to freely navigate through schematic representations of processes. By knowing that the same process can be visualized differently in books of different authors, students need their personal interpretation of the process in order for it to become understandable. For many students, however, perception of schemes proves to be difficult as they lack basic knowledge in chemistry. It can therefore be compared with reading a book without even knowing the alphabet. Illustration of causes and effects, comparison and opposition of terms, graphic

representation of quantitative solutions and understanding the essence of information can be effectively learned by developing graphic information organizer usage skills.

Gathering of information and its systemization during its initial phase must be guided by focusing attention towards following aspects:

"What is my attitude towards contents and what facts, ideas and arguments must I understand?

Which scheme will help me organize the material and display its meaning?

Which type of visual organizer will display type of content comprehension?

Which problems must be highlighted to activate student thinking" (Clarke, 1990)?

Lecturers must themselves realize why certain visual organizer is best suited for a specific goal. Only then is it possible to assist students in understanding adequacy of given visual organizer for systemizing certain facts, ideas and processes.

Information can be displayed linearly as a sequence of facts, as a net, hierarchy, matrix or block diagram (Halpern, 1996).

John H. Clarke developed two types of graphic organizers intended for different purposes:

1) From bottom to top - for information sorting and organization which helps students to draw conclusions by thinking inductively;
2) From top to bottom - for forming hypothesis, making decisions and solving problems by thinking deductively (Clarke 1999).

Graphic information organizers are a type of reflexion since they display the thinking process. At the same time they are suitable for evaluation purposes as they illustrate what was understood and known or what are the causes for errors.

## Conclusion

During first semester the majority of students can tackle tasks connected with critical thinking skills only within specially created study situations. Critical thinking - as an all-encompassing competence which can be used for a wide variety of problems and situations (ability characteristic to high level of critical thinking) - cannot be evaluated yet. It is therefore that only separate aspects of critical thinking within medical chemistry course were evaluated - specific skills for solving problems, ability to compare one's own solutions with solutions of other students, effectiveness of information analysis, choice of information credibility criteria and self-evaluation - all of which are characteristic to low level of critical thinking.

Experience gained over a period of five years allows concluding that intensive work with small groups by introducing students to different methods of information analysis, graphic information systemization and dialogue skill development methods is effective and should be promoted and developed further. Of equal importance also is the organizational experience which students gain by learning to plan their own time. E.g. weekly schedule can best be planned when the plan of whole semester is completely known. Weekly tests allow students to analyze the effectiveness of their work thus planning more time for harder to learn subjects. Students must gradually reach a conclusion that only they are responsible for own grades and that they must find ways to use the lecturers potential to its fullest rather than the other way around. At the end of each period of time (week, month, semester, year) students must look back to their achievements and determine, whether consistency and success were reached. Within this research two main aspects were verified: effectiveness of use of critical thinking methods within medical chemistry course and comparison of suitability of this approach for work with local students and students from abroad. The described didactic model is intended for ensuring quality of study process in medical chemistry course and is effective and suitable for students with different previous learning experience. By developing learning skills, students gain motivation to master critical thinking methods. These methods -

which serve as an instrument for analyzing information and structuring knowledge - can be successfully developed and used.

Student grades are determined by qualitative criteria for mastering course material and corresponding critical thinking levels which can be determined by final examination and questionnaire.

The purpose of the questionnaire was to find out whether the methodic solution for mastering medical chemistry course by using critical thinking development methods was effective and whether students have at least partially learned to:

- develop skill of searching information in study books as well as other sources;
- avoid planning tasks for overly large periods of time but rather for shorter periods e.g. from colloquium to colloquium;
- formulate tasks in a short and precise manner without trying to cover inapprehensible but rather appropriate for own level of competence;
- draw conclusions regarding existing experience and predict which methods of work will be more effective;
- self-dependently develop own study material by using suggested study material as well as other sources of information;
- critically evaluate and conclude what other information - aside from already given/suggested - is necessary and whether it is clear why something is not understood, and whether an opinion an authority on given subject is necessary;
- summarize what was done correctly and what could have been done better, and whether consistency and success were reached;
- transfer responsibility from lecturer to student - which must use the lecturers potential to its fullest.

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