

MEDICAL STUDENTS' PREPARATION FOR ANALYSIS OF STUDY MATERIALS IN THE CHEMICAL COURSE

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Abstract. *The ability to reproduce and assess the content of the text and its argumentation is the most important competence in any profession. Medical students' systematic approach to information analysis based on evidence-based medical principles can be already developed at the beginning of the study process in the theoretical courses. The goal of this research is to analyse the effectiveness of a didactic model that is based on critical thinking principles and includes a wide range of approaches to working with information. Learning by memorization has become dominant for medical students in Rīga Stradiņš University (RSU). The goal of the chemistry course is to shift the emphasis from fact memorization to knowledge construction, thus significantly changing students' analytic abilities. The chemistry course not only creates the conditions for understanding content but also improves skills in various methods of acquiring knowledge. When new knowledge is being constructed students learn methods for organizing and structuring information and each student has an opportunity to choose the appropriate amount of information and participation level. Study material is being analyzed sequentially from the simplest to the most complex i.e. by starting with elementary calculations and moving to integrate information from different disciplines. Didactic model based on critical thinking principles underpins "logical steps" and requirements (fact recognition, analysis, and interpretation, recognition of fallacies and concepts, the perfection of reasoning algorithms, interdisciplinary connections) orient students to critically evaluate information while searching for problem solutions. The results obtained in student surveys and final tests prove that the created model, which is based on critical thinking principles, ensures successful mastering of the chemistry course to students with any level of prior knowledge.*

Keywords: *substantiation of arguments, structuring of information, improvement of reasoning ability.*

Introduction

The aim of the described study is to analyze the effectiveness of the didactic model based on the principles of critical thinking, which provides a wide range of techniques for working with information. The practical implementation of the didactic model varies depending on the content to be acquired and the students' ability to work. Based on method evaluations in the questionnaire at the end of

the semester and student performance over six years, the most effective forms of work recognized are:

- Acquisition of science-based research methods that involve theories, their multiple practical testing, processing of statistical results, analysis and drawing of conclusions;
- Specially prepared tasks within which the student should evaluate the truthfulness, accuracy, errors or discrepancies of the offered facts;
- Learning situations where student activity is directed to an in-depth analysis of the proposed terms of the task, which includes the minimum of knowledge (facts, regularities), alternative material (which illustrates, proves an idea, general condition), informative material (to be used as a reference material for linking different sectors);
- Lecture materials that include logic-based illustrative examples;
- The study material “General Chemistry”, which is suitable for the specifics of medicine, which orient students to critically perceive information, to put forward hypotheses, to reflect, to engage in dialogue and discussions.

The developed didactic model has been adapted to specific study situations to ensure the acquisition of the study material in the chemistry course based on information analysis based on the principles of critical thinking also in situations where previous student knowledge is not sufficient. Elementary Skills of Student Critical Thinking (how to identify the problem, how to put evidence and arguments to identify contradictions and gaps in the selection and use of problems in problem-solving) are effectively developed on the basis of chemistry course material. Critical thinking methods (information analysis techniques, problem-solving, graphic information systematization options, dialogue skills and self-assessment) are useful in studying chemistry.

The created study material frees students from searching for mechanical information, thus allowing them to spend more time analyzing the illustrative facts and studying other literature. The content included in the study material “General Chemistry” fulfills the function of “work material”. Students are free to handle this electronic document by independently modifying it according to their goals and level of knowledge. The study material “General Chemistry” is designed to facilitate the creation of “personal” study materials based on both available and alternative sources of reliable information. Students get an understanding that, while observing fundamental regularities and critically approaching any issue, one can come to a deeper understanding of it. In the presentation of the content of the course of chemistry, many texts are adapted to the three-phase model of developing critical thinking: initiation (the stage of

systematizing the experience), conceptualization (the stage of forming personal images), reflection (the stage of realization of individual goals).

When the basic material is has been familiarized, the students are provided with controversial views, completely unconfirmed theories that open up a completely different perspective on solid knowledge. This is followed by discussing them, justifying and illustrating them with examples understandable by medical students.

Literature review

The peculiarity of modern higher education is that science is increasingly included in the educational process, forcing the academic staff to transform scientific information into study information. Students need to understand that the content of the chemistry course and the material provided in literature or other sources of information is not an unchangeable truth. Rather, it is just the current understanding of the structure and dynamics of matter studied by chemistry as an ever-changing discipline.

At the start of studies, the experience of young people in obtaining and analyzing information is very diverse. Often, students cannot judge whether one assumption arises from another, whether it is a prior known development, an illustration or contradiction. Reading texts often do not capture facts that are interdependent. The technical terms for students are not related to similar phenomena known in everyday life.

Critical reading is one of the proposed strategies for gaining meaningful reading experience for students (Manarin et al., 2015). Richard Paul qualifies reading as macro-abilities, as many of the microskills used are read in the reading process. Reading, contemplating vague terms, interpreting concepts. Based on personal experience, it is possible to find examples that confirm the author's statement, creating an understanding of reading (Paul, 1990). Macro-abilities is the processes involved in thinking, arranging individual elementary skills in an expanded order of thought, so that they are not fragmentary and unrelated (Fisher, 2005).

Students' basic knowledge, experience and cognitive factors influence their ability to understand the basic idea of the text. The complexity of the text is determined by five factors: vocabulary, sentence structure, coherence, organization, and background knowledge (Shanahan, Fisher, & Frey, 2012). Students' ability to understand the text depends on the unfamiliar general academic terms they encounter. It is necessary to look for the optimal ratio by combining complex texts with effective methods to perceive them. Efforts to maximize texts cannot increase students' analytical skills. Helping students learn from complex texts, introducing new general academic terms, provides the basis

for the ability to navigate future publications in their field. Scientific journals are not only the starting point of the information chain but also the "forum for specialist communication", as readers can also be authors at the same time (Weinreich, 2010).

Bringing attention to the emotional importance of teaching material, Jerom Bruner emphasizes that when faced with the reflection of personal problems in the teaching material, it becomes more attractive and important for students. Can't disagree with Jr. Bruner's opinion that the ability to spell out the essence of what is going on in the narrative requires special preparation for reading, analysis, and discussion. Only in this case can narration be made an instrument of mind (Bruner, 1996).

Information for a wide range of readers in the mass media can be emotionally attractive to an unprepared reader. As a result, text analysis deviates to the second plane.

Since facts are verifiable and verifiable information, but popular opinions are considered unreliable (Cottrell, 2017), it is not easy to distinguish them without much experience and knowledge. The text needs to find statements that can be accepted as indisputable so that they can make informed decisions on controversial issues (Brun & Hirsch-Hadorn, 2014). The principles of comprehension or understanding of text are known for centuries in the form of hermeneutic laws. Understanding the parts creates an understanding of everything and the common understanding is the consequence of understanding parts (Brun & Hirsch-Hadorn, 2014). Based on our previous understanding, we are expanding our knowledge to other (or the same) text, we are actually moving around in a circle or spiral, in a hermeneutic circle: a previous understanding, a question, a comparison with a "text," expanded understanding the context, new understanding of the text, refinement, changing the point of view (Gudjons, 2007). In the course of chemistry, the e-learning material contains not only theoretical material, examination tasks and descriptions of practical works, but also references to Internet resources. Therefore, when creating study materials, students with examples are interested in recognizing the analogy with the known theoretical material, reducing the distance between theoretical regularities and future clinical experience. Students are given the opportunity to search for and analyze popular, but erroneous opinions, as ignorant doctors are unacceptable. A trivial example (analysis of ad texts) can create the maximum contrast effect between true information and its questionable interpretation.

When reading such texts, it is important to follow the principle of favorable interpretation. To test the text, it must first be considered that one can agree with the author at least on basic questions. Only if the possible interpretations of the facts cannot be reasonably proved are the beliefs about the wrong views of the author (Brun & Hadorn, 2014). By learning the methods of text analysis, the

boundaries of their knowledge are identified, as well as general skills to express themselves clearly and to think critically. Being able to understand and evaluate texts is a good basis to be able to clearly outline and justify your position orally or in writing.

Methodology

The methodological task is to create a study environment in which intensive study methods and forms of learning, with the systematic acquisition of humanitarian, exact and clinical disciplines by prospective physicians, generate interest and deep, comprehensive understanding. Medical education combines the theoretical knowledge and practical skills acquired at the beginning of the studies, which are realized as competences in further work with patients under real clinical conditions. Acquisition of theoretical courses is subject to the acquisition of clinical courses, as the aim of medical education is not the training of highly erudite specialists. The didactic model based on critical thinking principles offers a wide range of techniques for working with information that:

- create conditions not only for understanding content but also for developing skills in using different cognitive methods to construct new knowledge;
- promote learning information exchange methods, including organization and structuring of information;
- let each student choose the appropriate level of professional growth, the amount of information and the degree of participation.

For example, the fundamental thermodynamic guidelines in the course of chemistry students learn by successively moving from general regularities to individual examples and vice versa - generalizing concrete examples to fundamental regularities. Based on the Critical Thinking Principles, the facts set out in the study material "General Chemistry" are based on the fact that the science teaching process should seek to educate students in a scientific approach characterized by curiosity, skepticism, logical reasoning and search for evidence:

- Cause - Consequence Learning and Perception of Knowledge in the Context of Existing Knowledge;
- The connection of different pieces of information for discerning the essentials from the non-essential;
- For analyzing misleading or selfish information and for sifting or rejecting ambiguous information;
- See stereotypes that can lead to wrong conclusions, avoiding categorical and prejudiced statements.

If the outcome of the work has to be understandable and well-grounded, reading without a simultaneous record of results and central considerations is largely meaningless (Brun & Hadorn, 2014). Identifying the most important ideas in reading and writing is the basis for text analysis in organizing information. Consistent writing not only allows you to gain more clarity and understanding of the text but will also allow you to respond later to your thoughts. Getting basic ideas for writing notes for students helps in the worksheet chemistry. Worksheets can be used in different stages of the lesson. They help to activate students at the initiation stage, organize a productive independent activity at the stage of understanding and synthesis, as well as analyze each error and personal contribution at the stage of reflection while receiving feedback. Individual work with worksheets is an integral part of the lessons, as it requires the need to repeat the study material and stabilize the knowledge. Worksheets are an example of selecting and analyzing factual material by creating and adapting study materials according to the peculiarities of each student's learning experience and study context.

By using assignments with different levels of difficulty and visual information (formulas, graphs, schemes) it is possible to involve students that aren't sufficiently prepared for the lesson since smaller assignments promote their self-reliance.

Although it is not possible to fully identify what students comprehend, it is important to formulate the most important goals in worksheets. Those goals being: comprehension, interpretation, evaluation (Manarin et al., 2015). Whether writing as a method will prove itself useful in other science courses within general education depends on many factors, but it does have potential (Quitadamo & Kurtz, 2007) since correctly formed writing assignments can develop higher-level thinking (Goodwin, 2014).

“Ultimately, and in an important sense, we are what we write, and we need to understand the distinctive ways our disciplines have of addressing colleagues and presenting arguments” (Hyland, 2013). In contrast to humanitarian disciplines where writing is a form of self-expression, exact science courses perceive writing as an instrument for analyzing information and presenting or interpreting facts. It must be highlighted that text analysis develop reflective thinking and compensates for deficiencies in existing knowledge.

Writing assignments must include transition from the presentation of an idea to linking multiple ideas and justifying them with well reasoned critical evidence (Bailey et al., 2015). Writing is a dynamic and multi-layered process that includes the transformation of comprehension and thinking and develops critical evaluation skills. The higher the student's level of critical thinking, the more effective is the use of newly gained skills in writing assignments.

Research results

Questionnaire results obtained over a period of six years show that students need understandable interconnections. Making information more accessible to themselves and to other students is an important precondition for comprehension. Students comprehend broad study texts better if they include a reference for the most important regularities. It isn't possible to create abstracts or notes without the selection of information source, adequate analysis of reading texts and critical evaluation of new facts. By developing critical writing skills in study process (Bailey, Zanchetta, Velasco, Pon, & Hassan, 2015) students learn to clearly and precisely analyze and evaluate ideas in texts and deepen their understanding of important concepts by finding relationships between them.

The chart summarizes the results of the survey over six years. (Fig. 1). During the study there is a tendency for students to use mostly exhaustive and concise information in the course of chemistry. Only in the study year 2013/2014 and 2013/2014, the minimum number of responses (55% - 58%) at the beginning of the semester appears on the question "I prefer summarized information and ready-made conclusions". At the end of the semester, the situation is similar throughout the years, as the large amount of material to be taught in other study courses forces students to reduce their time spent studying and use the most concise materials possible.

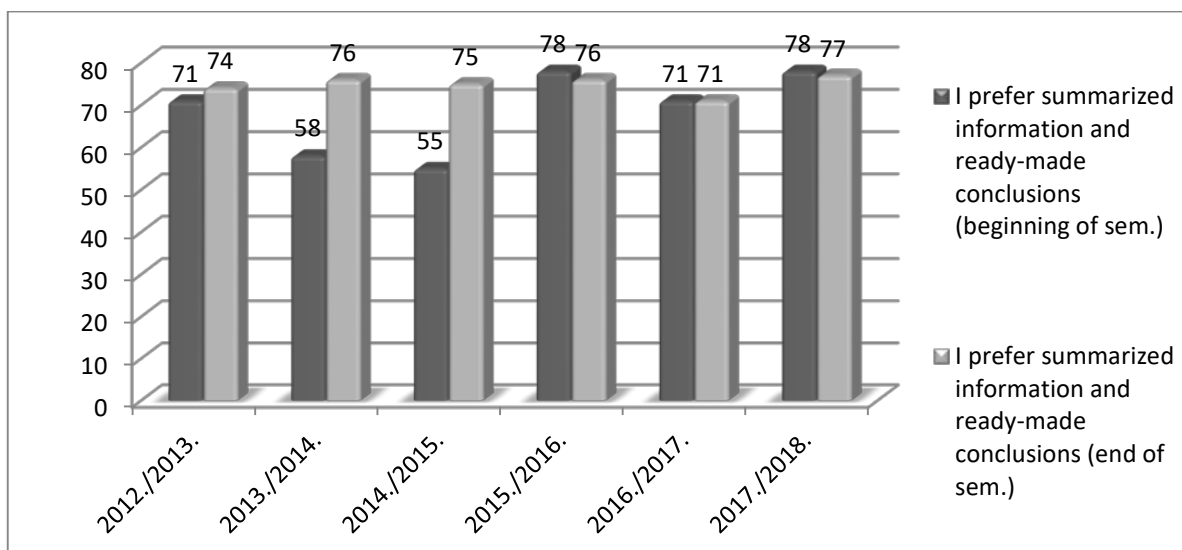


Figure 1 The Significance of summarized information in the study process

Students need examples of how to find connections between ideas. By focusing attention on essential aspects and their explanations transformation of information and its inclusion in education is made easier. Due to the small number

of assignments and theoretical material in worksheets, students gain self-reliance and are motivated to take part in discussions and find solutions. Such a principle of material presentation creates a concept and realization of a larger theoretical material. Student attention is directed towards the level of likeness or difference of researched objects, phenomenon or processes. The benefit of worksheets is in immediate use of theoretical knowledge either for practical or laboratory work. Student notes based on a pattern provided by worksheets integrate new knowledge and transform it into basic knowledge during lessons. It was an important point to find out via questionnaires whether notes written by students and information analyzed during lessons don't contradict. 136 students (94%) of respondents didn't see contradictions between their own notes and information interpretation provided in worksheets (Fig. 2). Questionnaires were filled in by 144 respondents in the study year 2018/2019 of whom 136 students (94%) in the study year positively evaluate the use of worksheets for analysing new study material (Fig. 3).

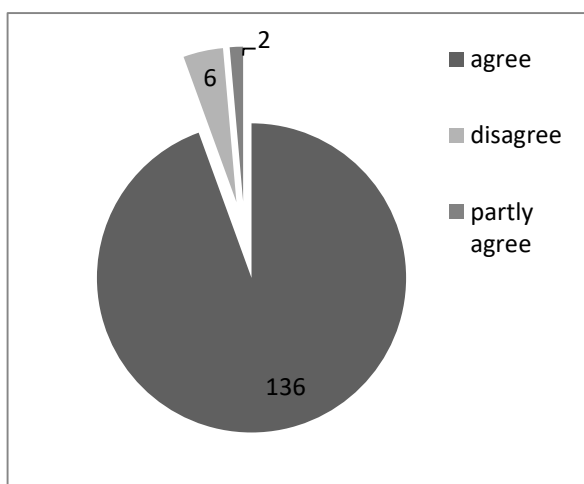


Figure 2 The worksheets do not contradict the information that is independently compiled and analyzed in the lessons

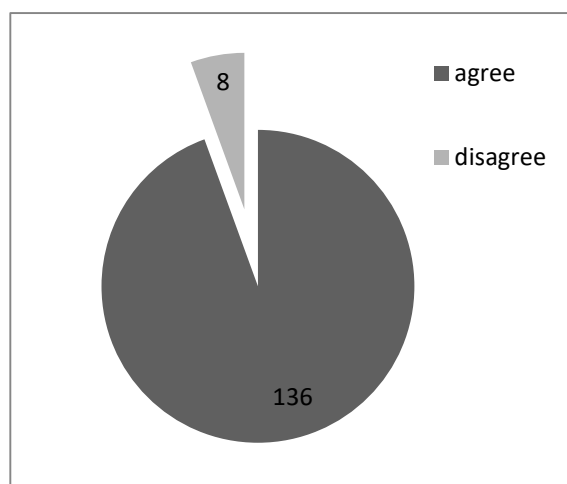


Figure 3 The worksheets offered in the lessons facilitate the capture of information

It must be noted in the end that methods based on critical thinking principles (fact recognition, analysis, and interpretation, recognition of fallacies and concepts, the perfection of reasoning algorithms, interdisciplinary connections) used within the didactic model motivate students to critically evaluate and structure new information.

Conclusions

- Analysis of chemistry course material happens while sequentially going through all study phases from the simplest to the most complex i.e. from simple calculations to the integration of information between disciplines.
- The developed study material “General chemistry” and worksheets in medical chemistry course serve as an example of selection and analysis of factual information by forming and adapting study material to conform to each student's study experience and study context.
- The study highlighted the exhaustive and concise use of information. Worksheets make the self-dependent learning process more productive by activating students in all phases of the lesson and by providing immediate feedback.
- The results of the questionnaires confirm that the didactic model based on the principles of critical thinking, which provides a wide range of techniques for working with information, is effective and can be used in different study situations.

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