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ORIGINAL ARTICLE

COMPARISON OF METACOGNITIVE AWARENESS OF MEDICAL STUDENTS DURING TWO YEARS FOLLOW UP

UPOREĐIVANJE METAKOGNITIVNE SVESNOSTI STUDENATA MEDICINE U PERIODU OD DVE GODINE

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Abstract

Introduction: Metacognition is "thinking about thinking". Metacognitive skills include planning the way to approach tasks, finding the flaws in specific strategy, monitoring comprehension or evaluating the end result of the learning process. High level of metacognitive awareness allows the person to reach the right conclusion and, therefore, ensures efficient and reliable work.

Aim: The aim of the research is to identify and evaluate the metacognitive strategies used by the third year medical students and compare them with the results of the testing performed with the same generation of students during their first and second years of study.

Material and methods: We compared the results of metacognitive awareness of the same generation of the medical students tested in the first, second and third year of training at the Faculty of Medicine, University of Niš. The procedure included 40 students in the first, second and third year (each) at the Faculty of Medicine, with no gender/age restrictions. The instrument used was the "Metacognitive Awareness Inventory". The instrument consists out of 52 questions and two possible answers: true/false. The questions are grouped into 8 domains: declarative knowledge, procedural knowledge, conditional knowledge, planning, information management strategies, debugging strategies, comprehension monitoring and evaluation. We compared the average number of positive responses by the group.

Results: Comparison of third and second year students showed a significant difference in the following domains: information management strategies (8 vs. 8.575), debugging strategies (4.25 vs. 4.575) and evaluation (3.725 vs. 4.325). First year students have outperformed the third year students in seven of eight tested domains, with the exception of procedural knowledge.

Conclusion: Metacognitive awareness of medical students is changing during the studying period. We believe that pointing out the strategies for learning and mastering materials before and during the studies should have positive effects on the students.

Keywords:
metacognition,
metacognitive awareness,
metacognitive awareness inventory,
education,
learning strategies

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Sažetak

Uvod: Metakognicija je „mišljenje o mišljenju". U metakognitivne veštine spadaju planiranje, identifikacija grešaka i nedostataka određenih strategija, praćenje razumevanja, evaluacija napretka i rezultata rada. Visok nivo metakognitivne svesnosti omogućava pojedincu da dođe do ispravnog zaključka, te tako obezbeđuje efikasan i pouzdan rad.
Cilj: Cilj rada je utvrđivanje metakognitivnih strategija koje koriste studenti treće godine Medicinskog fakulteta u Nišu i upoređivanje dobijenih rezultata sa rezultatima utvrđivanja metakognitivnih strategija studenata iste generacije na prvoj i drugoj godini studija.
Materijal i metode: U radu su upoređeni rezultati testiranja metakognitivne svesnosti studenata treće godine Medicinskog fakulteta u Nišu i rezultati testiranja iste generacije studenata na prvoj i drugoj godini studija. Obuhvaćeno je po 40 studenata prve, druge i treće godine, bez obzira na pol i godište. Korišćen je instrument „Inventar metakognitivne svesnosti". Instrument se sastoji od 52 pitanja na koja se odgovara sa tačno ili netačno i koja su grupisana u 8 domena: deklarativno znanje, proceduralno znanje, kondicionalno znanje, planiranje, strategije upravljanja informacijama, strategije ispravljanja grešaka, monitoring razumevanja i evaluacija. Upoređivana je srednja vrednost broja pozitivnih odgovora po grupi. Za statističku analizu podataka korišćen je t-test.
Rezultati: Upoređivanjem srednjih vrednosti studenata treće i druge godine studija nađeno je da statistički značajna razlika postoji u sledećim domenima: strategija upravljanja informacijama (8 vs. 8,575), strategija ispravljanja greške (4,25 vs. 4,575) i evaluacija (3,725 vs. 4,325). Studenti prve godine studija postigli su bolje rezultate od studenata treće godine u sedam od ukupno osam ispitivanih domena, sa izuzetkom domena proceduralnog znanja.
Zaključak: Metakognitivne sposobnosti studenata menjaju se tokom perioda studiranja. Smatramo da bi bilo dobro da se studentima na početku i u toku studija ukaže na strategije učenja i savladavanja gradiva.

Ključne reči:
metakognicija,
metakognitivna svesnost,
inventar metakognitivne svesnosti,
obrazovanje i metakognicija,
strategije učenja

Introduction

Metacognition is "thinking about thinking". It refers to a level of thinking that involves active control over the thinking process. It is a regulatory system that helps person to understand and control its own cognitive processes. Metacognition can refer to what someone knows (metacognitive knowledge), what someone is doing at the moment (metacognitive strategies) or what someone is experiencing or feeling (metacognitive experience) (1). It allows the person to control its own learning process and raise the awareness of studying techniques, and ways to approach the learning tasks, evaluate, generate and apply optimal learning strategies. Increased efficiency of thinking sizes up motivation for learning and, in a way, insures greater success in completing tasks. Mastering of metacognitive techniques is followed by enhancement of self-confidence. The person can usualy define metacognitive strategies that he/she is using. Regardless of age, metacognitive knowledge is crucial for efficient, independent learning because it improves self-insight and enables developement of learning habits and correct ways of approaching various tasks.

Metacognition has two components: knowledge about knowledge (metacognitive knowledge) and knowledge regulation (2).

Metacognitive knowledge has three elements (3). First is declarative knowledge. It is the factual knowledge the learner needs before being able to process or use critical thinking related to the topic. Second domain is procedural knowledge: it refers to the application of knowledge for the purposes of completing a procedure or process and also knowledge about how to implement learning strategies. Students obtain it mostly through problem solving, discovery and cooperative learning. Highly developed procedural knowledge enables the individual to perform the task more automatically. This is achieved through number of different strategies that can be aproached more efficiently. Third domain is conditional knowledge. It refers to the determination under what specific circumstances, when and why certain skills and learning strategies should be used. It enables the students to abstract their resourses when using learning strategies and become more efficient at styding or developing, perfecting certain skill.

Managing the metacognition or "knowledge regulation" also has three elements: planning, comprehension monitoring and evaluation (3). Planning includes allocating resources prior to learning, as well as goal setting. It implies selection of appropriate learning strategies and distribution of resources that have an effect on task performance. Comprehension monitoring is assessment of one's learning or strategy use. Students who score high in this domain know when they understand what they are learning and can more easily adress the gaps in their understanding. Evaluation refers to analysis and assessment of performance and strategy effectiveness after a learning episode. It can include re-examination strategies.

We've also examined information management strategies and debugging strategies (3). Information management strategies is metacognitive domain that represents skills and strategy sequences used to process information

more efficiently. Organizing, summarizing, elaborating, selective focusing are some of the strategies in this group. Debugging strategies are set of skills that are used to correct comprehension and performance errors.

Students that possess wide range of metacognitive skills are more efficient at completing assigned tasks. They are the ones that are using "right tools for the work" and are modifying learning strategies and knowledge based on their awareness of metacognitive efficiency. Individuals with high level of metacognitive knowledge and skills identifiy blocks and problems in learning process sooner and are changing "tools" to ensure overcoming obstacles and reaching goals (4). In 1990, scientist H. Lee Swanson found out that metacognitive knowledge can compensate IQ and lack of previously acquired knowledge when comparing results between fifth and sixth grade students (5). Students with high metacognitive skills are using a smaller number of strategies, but are solving problems more efficiently than students with low metacognitive abillities, regardless of IQ or level of previously acquired knowledge.

In 2011, The American Association for the Advancement of Science (AAAS) set the goals in education for biology students, where biology in the 21st century requires students to learn how to integrate concepts at different levels of organization and complexity, and to synthesize and analyze information that links conceptual domains (6). One of the goals was teaching the students to use metacognition so that students could be able to understand better how to think about biology, which is significant step towards developing students' advanced scientific thinking skills.

Through education an individual should be able to gather the necessary skills that can help him/her in information managing so that learned information could be used to draw reasonable conclusions. In a way, education is partly based on learning new metacognitive skills.

The aim of the investigation is:

1. Determine the metacognitive strategies used by the third year medical students, Faculty of Medicine – University of Nis;

2. Comparing the obtained results with the results of the testing performed with the same generation of students during their first and second year of study.

Material and methods

We compared the results of metacognitive awareness of the same generation of the medical students tested in the first, second and third year of training at the Faculty of Medicine, University of Nis. The procedure included 40 students of the first, second and third year (in each) at the Faculty of Medicine. Students were tested for the first time in 2016, second time in 2017, and third time in 2018. There were no gender/age restrictions. An instrument used was "Metacognitive Awareness Inventory" (7). The instrument consists of 52 questions that are answered with true/false. For affirmative answer the participants were given 1, and for negative answers 0 points. The questions are grouped into 8 domains: declarative knowledge, procedural knowledge, conditional knowledge, planning, information management strategies, debugging strategies, comprehension monitoring and evaluation. We compared the average number of positive responses by the group. For statistical analysis we used Student's T-test.

Students were notified before the testing that their participation is voluntary and anonymous, and that their answers will help us to better understand thought process of students during early education period. There was also a short explanation of what metacognition is, and what is required to complete the questionnaire.

Results

Comparing results of second and third year students, Chart 1. and Table 1. show statistically significant decline in three metacognitive domains: Information management strategies (8 vs. 8.575), Debugging strategies (4.25 vs. 4.575) and Evaluation (3.725 vs. 4.325). The results also indicate a statistically significant decline in seven out of eight tested domains, comparing

Table 1. Middle values noted for first, second and third year students by the domains

Group/Year of study	First year	Second year	Third year
Declarative knowledge	5.875	5.65	5.35 (ns)
Procedural knowledge	2.525	2.85	2.825 (ns)
Conditional knowledge	3.775	3.45	3.35 (ns)
Planning	4.825	4.35	4 (ns)
Information management strategies	8.65	8.575	**8 (p<0,05)**
Debugging strategies	4.6	4.575	**4.25 (p<0,05)**
Comprehension monitoring	5.125	**4.55 (p<0,05)**	4.65 (ns)
Evaluation	4.35	4.325	**3.725 (p<0,05)**

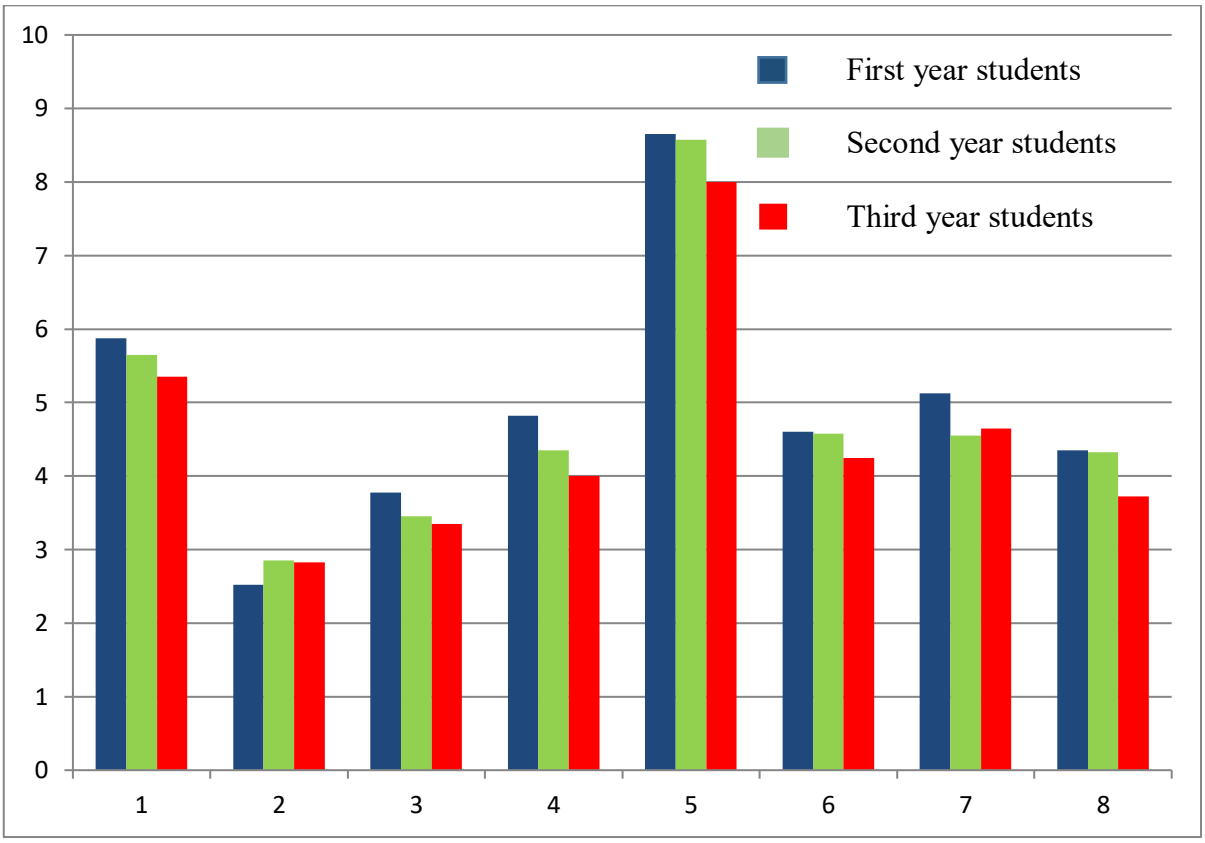

Figure 1. On the abscissa of the Chart 1, groups of questions are numericaly noted in the following order: 1. Declarative knowledge; 2. Procedural knowledge; 3. Conditional knowledge; 4. Planning; 5. Information management strategies; 6. Debugging strategies; 7. Comprehension monitoring; and 8. Evaluation. The average numbers of positive answers by the groups are noted on ordinate.

students of the first and the third year, where the first year students outperformed the third year students: Declarative knowledge (5.35 vs. 5.875), Conditional knowledge (3.35 vs. 3.775), Planning (4 vs. 4.825), Information management strategies (8 vs. 8.65), Debugging strategies (4.25 vs. 4.6), Comprehension monitoring (4.65 vs. 5.125) and Evaluation (3.725 vs. 4.35).

Disscusion

Mastering the learning content covered by students of the first and the second year (surveyed in January 2017) does not employ complex metacognitive skills to a great degree. The metacognitive domain the students utilized the most in this period of their studies is the domain of declarative knowledge. Exams in the earliest part of studies are mostly based on learning basic facts related to the morphological aspect of the human body. We therefore believe, that is the main reason there were no statistically significant changes across metacognitive domains. In the interpretation of the results, it is important to emphasize that students carried out a self-evaluation. It is only with the increased complexity of the learning content in later years of studies that statistically significant differences occur in a greater number of domains. The exams in later years of studies involve a highly active use of all metacognitive domains. The results indicate a statistically significant decline in seven out of eight domains that were tested in students of the first and the third year. This could be accounted for by a better insight that older students have into their own abilities, whose learning skills and comprehension of complex processes were only "put to the test" in this part of their studies for the first time. We believe that facing this type of intellectual challenge resulted in stricter self-evaluation and poorer results compared to those achieved by younger students. Naturally, we should hypothetically take into consideration the possibility that metacognitive awareness in students decreased in the first two years of studies due to uneven, yet extensive, use of certain metacognitive domains. It is our belief that the findings of this research could give rise to the discussion on improvements to be made in education and its approximation to the up-to-date education systems, and may also be useful in singling out possible aspects of education that may be upgraded. As Gall M.D. and his associates are pointing out: "Learning how to learn cannot be left to students. It must be taught" (8).

Another fact to support such interpretation is that metacognitive skills such as declarative, procedural and conditional knowledge changed the least in the course of the two years of studies. In addition, there were no statistically significant differences across the abovementioned domains, when comparing the results over a one-year period.

It is essential to stress the decline in the evaluation domain, that is, the assessment of the learning efficiency and learning results and one's own knowledge. It is possible to assess one's own knowledge with greater certainty in the first years of studies as such knowledge relates to

the recognition of facts, numbers, names, the exact localization of certain structures, etc. In later years, the emphasis is placed on understanding and connecting the facts that have been learned. This is what makes the evaluation of such knowledge more complex. The results obtained from third year students indicate so. We find that the observed declining trend in such domains should be monitored and analyzed, in the course of a later period of studies.

We also think that average students of the second and the third year should have a higher metacognitive awareness than first-year students, having in mind the fact, among others, that these are the students who have passed a certain number of exams and enrolled in the next year of studies and have, therefore, faced more demanding intellectual challenges than students who have only enrolled in the first year of studies, or university. Thus, it is reasonable not to expect significant changes or to expect changes in terms of improved results, although, the results suggest that no statistically significant improvements were reported across any of the metacognitive domains.

The survey conducted two years ago (January 2016), involving medical students of the first and the sixth year, established a slight cognitive decline in older students in the following three domains: planning, information management strategies and debugging strategies; whereas there was no statistically significant difference in the findings regarding other domains compared to the results of first-year students (9).

The study carried out last year (January 2017), involved the survey of second-year students. The results showed that the only statistically significant difference compared to first-year students was in the domain of comprehension monitoring, where second-year students had a poorer performance than first-year medical students (10).

Metacognition allows complete understanding of the knowledge an individual has, correct comprehension of tasks, understanding of necessary knowledge and skills, the agility to reach the right conclusion and efficient and reliable work. Therefore, we believe it is advisable to provide students with information on learning strategies at the beginning of their studies and in the course thereof.

Another explanation of why metacognitive abilities should be the focus of education can be found in the excerpt of Charles Fadel, Maya Bialik and Bernie Trilling book called "Four-Dimensional Education: The Competencies Learners Need to Succeed", regarding the meaning and purpose of developing metacognition. "At its core, it is a basic survival strategy, and has been shown to be present even in rats. Perhaps the most important reason for developing metacognition is that it can improve the application of knowledge, skills, and character qualities in realms beyond the immediate context in which they were learned. This can result in the transfer of competencies across disciplines - important for students preparing for real-life situations, where clear-cut divisions of disciplines fall away and one must select competencies from the entire gamut of their experience to effectively apply them to the challenges at hand" (11).

Conclusion

Metacognitive awareness of medical students is changing during the studying period. We believe that pointing out to the strategies for learning and mastering materials before and during the studies should have positive effects on the students.

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