Journal of the Serbian Chemical Society
JSCS-info@shd.org.rs • www.shd.org.rs/JSCS

ACCEPTED MANUSCRIPT

Please cite this article as F. Stašević, A. Bubanja, A. Maksimović and J. Đurđević Nikolić, *J. Serb. Chem. Soc.* (2024) https://doi.org/10.2298/JSC231227069S

Journal of the Serbian Chemical Society
JSCS-info@shd.org.rs • www.shd.org.rs/JSCS
J. Serb. Chem. Soc. **00(0)** 1-19 (2024)
JSCS–12747
Original scientific paper
Published DD MM, 2024

Chemistry educational outcomes and standards in Serbia and Montenegro. Analysis of the teachers' attitudes and high school students' achievements

FILIP STAŠEVIĆ[1], ANDREA BUBANJA[2], ALEKSANDRA MAKSIMOVIĆ[1] AND JELENA ĐURĐEVIĆ NIKOLIĆ[1]*

[1]*University of Kragujevac, Faculty of Science, Radoja Domanovića 12, 34000 Kragujevac, Serbia and* [2]*Grammar school „Panto Mališić“, Beranselo VIII/6, 84300 Berane, Montenegro.*

(Received 27 December 2023; revised 21 February 2024; accepted 9 July 2024)

Abstract: Standards and outcomes-based education led to significant adjustments in school organizations and contributed to the in-depth analysis of teachers' professional identity. This research aimed to examine the chemistry teachers' attitudes in the context of the implementation of the educational outcomes and standards in educational policy and in the school practice, as well as to ascertain the level of accomplished learning outcomes for the selected teaching topic “Lipids“. The research sample included both, chemistry teachers (N=4) and high school students (N=172) from two countries, Serbia and Montenegro. The data were analyzed qualitatively jointly for two countries using mixed-methods research and constant comparison of the data. There are no significant differences in teachers' attitudes as well as in achievements among students between these two educational systems. All teachers emphasized the importance of learning outcomes and standards and confirmed that they help them in organizing lessons and monitoring students' assessments. However, interviewed teachers pointed out the need for support and consideration of teachers’ opinions about implementing educational changes. The results obtained on the knowledge test have highlighted that knowledge about “Lipids” among students is not at the expected level.

Keywords: chemistry teaching; educational policies; students' assessments, teachers' perspectives.

INTRODUCTION

Changes in education and educational systems are common occurrences and demand monitoring, examining, and analyzing in certain ways.[1] Introducing innovation is not an easy process, and the success of the novelty depends on numerous factors.[2,3] For decades, the Serbian educational system has been

* Corresponding author. E-mail: jelena.djurdjevic@pmf.kg.ac.rs
https://doi.org/10.2298/JSC231227069S

criticized as highly centralized, while the most important shortcomings of the chemistry curriculum refer to its extensiveness, generalization, and abstraction.[4-6] Related to this, the educational reforms based on standards and outcomes started in the 2000s[7] but outcomes were not implemented until 2018/2019 when they were first applied in the first and the fifth grade of primary school, and in the first year of general secondary education.[8-10] Meanwhile, in 2009, the National Education Council of the Republic of Serbia announced educational standards for the end of compulsory education.[11] The standards for the end of the first cycle of compulsory education were defined in 2011, whereas the standards of students' achievement for the end of general secondary education and general education subjects in secondary vocational education were created in 2013.[12,13] In Montenegro educational reforms were also intensively conducted since the 2000s, and along with respecting the principle of individuation, imposed in 2017 the development of curriculum based on learning outcomes.[14,15] Revised educational programs that included outcomes were put into practice in 2019 for primary and vocational schools, and in 2020 for grammar schools.[16,17] In both countries, there has been trainings that should help teachers realize education based on standards/learning outcomes.[18-20] In Serbia, training for the implementation of achievement standards started in 2016 and for outcomes in 2017 both by the Institute for the Improvement of Education and Training. In Montenegro, training began with the realization in 2019-2021 by the Institute for Education of Montenegro. Since then, every year there has been trainings on this theme.

In Serbian and Montenegrin educational systems, outcomes have the same meaning and show the desired and expected results expressed in the form of skills and knowledge that the student possesses at the end of a certain school year.[21,22] In terms of outcomes, neither quality nor quantity is specified. On the other hand, the crucial quality of implementing standards in educational policy and practice is that they are expressed in terms of measurable students' behavior.[23,24] In Serbia standards of achievements define the required knowledge, skills and attitudes for solving different social challenges. Accordingly, standards can be understood as both, mandatory and recommendative, depending on the educational context. For example, at the primary school level, it is specified that 80 % of students should achieve chemical knowledge at the basic level of standards of achievement.[25] As the standards of achievement for secondary school represent expanded knowledge, skills, and attitudes relative to those determined for primary school, it is expected that all high school students should achieve a basic level of standards of achievement.[11] In Montenegro, educational standards and outcomes are used interchangeably, and they are set in educational programs for each subject by the Institute for Education of Montenegro, as well as in assessment catalogs, adopted by the National Council for Education.[26,27] The choice of a document depends on

the teacher since standards/learning outcomes are defined very similarly in both. Both Institutions are part of the Ministry of Education, Science, Culture and Sports.

There are certain similarities but also differences between outcomes and standards. The main similarity is that both define what the student should know at the end of the educational process (the outcomes refer to the end of the school year, and the standards to the end of the educational cycle). The difference is that the outcomes are broader (the teachers could choose teaching methods and how they will present the material) while the standards are limited to a certain extent (teachers receive detailed instructions for work).[28] To evaluate students in a useful and correct way, it is necessary to use outcomes and standards. Outcomes show what students learned, while achievement standards show how successful learning was.[29]

Proper usage of educational outcomes and standards is not a simple activity. For the appropriate management of outcomes and standards, the teacher must understand and know how to apply the outcomes and standards in the right way. Teaching outcomes and standards can help both, teachers to organize teaching that is adequate for the realization of the potential of each student, as well as students and parents as guidelines for them to follow during studying. In all countries, during the creation and implementation of standards, one of the biggest problems was disagreement among experts on what are the most important concepts in certain areas, as well as the content of the standards. Also, there were problems with teachers' training and designing and enforcement of procedures for monitoring and measuring the achievement of standards. Furthermore, in Serbia, there are no chemistry educational outcomes and standards that include knowledge of certain areas, and some basic chemical terms and laws.[30]

In light of this, the authors wanted to explore how the Serbian and Montenegrin chemistry teachers understand and apply the educational outcomes and standards, as well as to discover the level of accomplished outcomes among high school students for the selected teaching topic. Accordingly, the aim of the research is not to evaluate the reform or any educational change. The authors emphasize that every idea that starts from the creators of educational policy arrives in the classroom, and at the end, the main protagonists are students and teachers. The value of this research lies precisely in including the perspectives of both, teachers and students.

EXPERIMENTAL

Research aims and research questions

The change in teaching based on standards and outcomes led to significant adjustments in school organizations and the perception of teachers' professional identity.[31] The educational outcomes and standards emphasize the conditions that are prerequisite for unfolding of the learning process. Students cannot have a high

level of achievement without qualified teachers who constantly upgrade their competencies through professional development, adequate time for learning, necessary equipment and materials for learning, and an appropriate school environment. This research aimed to examine the chemistry teachers' attitudes in the context of the application of educational outcomes and standards, as well as to ascertain the level of achieved learning outcomes for the selected teaching topic "Lipids". Furthermore, the paper contrasts teachers' attitudes towards educational outcomes and standards in Serbian and Montenegrin secondary education with the teachers' attitudes in other parts of the world.

Due to strong historical ties education in Serbia and Montenegro is structurally similar. Education in both countries is divided into four cycles: pre-primary, primary, secondary, and tertiary.[21,32] Primary education in Serbia is compulsory, it lasts for eight years, starting from the age of 7, and is divided into two cycles, each one lasting four years. Before primary school, a pre-primary educational period of one year is mandatory. Secondary education is provided in high schools, grammar or vocational. In Montenegro, the duration of primary (compulsory) education is extended to nine years, starting from the age of 6. Nine-year primary education is divided into three cycles, each one lasting three years. General secondary education (grammar schools) is not compulsory and lasts for four years. After the completion of secondary education, students can start education at the tertiary level choosing between high schools of applied studies (lasting 3 years) and universities (Bachelor programs lasting 4–6 years, Master programs lasting 1-2 years and PhD programs lasting 3 years) in both countries. Although the two countries share some educational features and have a similar educational structure, each has an independent educational program. After 2006 each country strived to find its own educational *milieu* (participation in PISA, increase in the number of university graduates, adoption of educational outcomes and standards). The teaching curriculums for the grammar school (general stream of studies) in Serbia and Montenegro include the same content. Students in both states firstly elaborate on general chemistry with thermochemistry (first grade), then anorganic chemistry (second grade), organic chemistry (third grade) and in final year biochemistry (fourth grade). Also, both curriculums propose learning outcomes for each topic and the same number of classes (2) per week. More details about proposed learning outcomes in the curriculum will be given in the section *Instrument/Design*.

Accordingly, the following research questions were posed:

1. What are the attitudes chemistry teachers' from Serbia and Montenegro hold in regard to educational outcomes and standards?

2. To what extent are educational outcomes for the teaching topic "Lipids" which is elaborated in the fourth grade of grammar schools, accomplished in Serbia and Montenegro?

3. What is the difference in the level of accomplished chemistry educational outcomes for the teaching topic "Lipids" between the fourth-grade grammar-school students from Serbia and Montenegro?

Sample/Participants

The research sample included both chemistry teachers and grammar school students. A convenience sampling design was applied for the teachers' sample. The sample size corresponds to the availability of teachers at the moment of research. A heterogeneous sample (N=172) encompassed grammar school students from grammar school in Kragujevac, Serbia (N=83) and grammar school in Berane, Montenegro (N=89). All students attended the 4th grade of the grammar school, the general stream of studies. The curriculum of the two countries encompasses a similar number of lessons per year, 68 in the grammar school in Montenegro and 66 in the grammar school in Serbia. For the topic "Lipids", all four teachers planned 5 lessons and similar learning outcomes, hence, all participants were equipped with the necessary knowledge and skills for solving the knowledge test. The four teachers, two from both countries, were involved in the research. The sample included 3 female and 1 male chemistry teacher with 10-20 years of teaching experience. Based on years of experience, only one was employed after implementing standards and outcomes-based education, whereas three were in a transition phase and had to adapt to a new concept of education.

Instrument/Design

The data were collected by means of an interview and specially designed knowledge test in the 2022/2023 school year. Two instruments were used for a deeper understanding of the phenomenon of standards- and outcomes-based education. The first should give insight into teachers' perspectives and second unveil how successfully the idea of introducing outcomes was realized from the aspect of improving students' achievements. A semi-structured interview protocol was created to examine teachers' attitudes toward standards- and outcomes-based education. The interviews were conducted in person with each respondent individually, in the schools where the teachers are employed. Participation in interviews was voluntary, and their duration was between 50 and 70 minutes both in Serbia and in Montenegro. The participants were guaranteed confidentiality, and interviews were recorded and transcribed. The authors emphasize that the results reported in this paper do not represent all teachers' opinions and practices regarding the implementation of educational outcomes and standards in Serbia and Montenegro. Still, they do provide some information about teachers' attitudes related to the educational standards and outcomes. In order to explore to what extent the educational outcomes for the teaching topic "Lipids" in the fourth grade the two above-mentioned grammar schools are accomplished, a knowledge test was created based on outcomes defined in teachers' lesson plans. Teachers from both schools define and state educational outcomes in their lesson plans, which is

not done with the standards, and only for that reason the knowledge test contained questions grounded on outcomes and not standards. The committee of experts (high school chemistry teachers and university chemistry teachers) who were not involved in its design confirmed the instrument's validity. Based on the evaluations, the revised items were held in the instrument. The framework formulations of questions from the interview and knowledge test are given in Supplementary Material.

Learning outcomes for all teaching topics for the subject Chemistry could be found in educational documents proposed by corresponding institutions from both states.[10,26] The teaching curriculum for fourth grade grammar schools (general stream studies) in both countries includes the same content, biochemistry and biologically important compounds. Regarding content, the only difference among curriculums is the period of elaboration on the teaching content. For example, according to the curriculum, students from Montenegro learn about the "Lipids" in November, whereas Serbian students study "Lipids" in April/May. Both curriculums define learning outcomes for each teaching topic but in a different way. In Serbia, outcomes are broadly defined, and teachers must specify them for personal lessons. However, within the Montenegrin document outcomes are already specified. Accordingly, differences in defined outcomes in teachers' personal lesson plans are expected. Learning outcomes for the topic "Lipids" defined by teachers from both schools are given in Supplementary Material. The outcomes predicted by teachers from Montenegro are more detailed than outcomes defined by Serbian teachers, which is probably the effect of the curricula they use. Furhermore, noticeable is the difference in the levels of knowledge defined by these outcomes (defines, states, recognizes, knows, connects vs. observes, explains, writes, analyzes).

The reason for choosing the topic "Lipids" was the presence and role of the selected compounds in daily life, as well as a similar number of lessons regarding this teaching topic in both schools. A set of questions covered by the instrument was chosen under previously defined learning outcomes by teachers. The instrument was designed with the intention to examine whether students achieve predicted learning outcomes and to what extent. Students should get the necessary knowledge and skills to solve the test within the same number of lessons in both schools. The first category of questions (first two questions) relates to the knowledge about the chemical structure of lipids and covers the following outcomes: "*defines lipids according to their chemical composition*" and "*knows the structure of chemical compounds that make up the composition of triacylglycerol, phospholipids, and sphingolipids*". The second category of questions (third and fourth) relates to the role and importance of fats and oils in everyday life. The outcomes that shaped these questions are: "*connects the*

structure of lipids with properties and roles in living organisms" and "*analyses the biological role of triacylglycerol, phospholipids and sphingolipids*".

RESULTS AND DISCUSSION

The data were analyzed jointly for Serbia and Montenegro, using mixed-methods research.[33] The data obtained from the interview were analyzed using a thematic analysis approach and the method of constant comparison.[34,35] Understanding teachers' perceptions of their roles and competencies is critical for designing systems of support that can improve teachers' practices. A lot of attention is devoted to studying the perspective of teachers, taking into consideration that everyday school practice critically depends on teachers' understanding of specified requirements.[36,37] The results from the knowledge test were analyzed qualitatively. Answers were scored as correct, partially correct, wrong, and without answer, and descriptive statistics will be provided in the form of percentages.

Furthermore, this section will describe Serbian and Montenegrin chemistry teachers' responses to questions from interviews in four categories: teachers' perspectives of educational outcomes and standards, teachers' understanding of educational outcomes and standards, teachers' attitudes about the adequacy of educational outcomes and standards and teachers' personal assessment of the implementation of outcomes and standards in teaching. Along with the analysis of the answers, some of the responses of all four teachers will be shown using abbreviations (ex. CTS1/2-Chemistry Teacher from Serbia 1 and 2; CTM1/2-Chemistry Teacher from Montenegro 1 and 2).

Teachers' perspectives of educational outcomes and standards

The first category of questions was related to teachers' information about the implementation of educational standards and outcomes. Analysis of these responses should give an insight into whether and in what way chemistry teachers were informed about standards and outcomes-based education. Also, the involvement of teachers in the process of creating learning outcomes and standards was examined.

All teachers stated that although they were informed about the outcomes and standards, this was not done in a sufficient and adequate way. The teachers from Montenegro point out that they were not informed specifically, except through a general lecture by the agent from the Ministry of Education with explanations of how and in what way the standards/learning outcomes can be useful to the teacher. Some of the answers were:

"*They informed us about it in such a way, that I remember for a long time I didn't even know how to use standards properly*." (CTM1)"

"*The standards are something that I remember from the first day of my work experience. To the greatest extent, it was my colleagues who explained to me how*

learning outcomes and standards work, and because of that, it was easier for me to catch up on things." (CTM2)

Teachers in Serbia were informed about outcomes and standards through practical training, carried out at the national level. They emphasized that every year there are trainings for novice teachers. One of the teachers particularly emphasized the importance of the training:

"*In my opinion, without that training, teachers who are just starting to do this job, would not be able to start working*." (CTS1)

None of the interviewees was involved in the process of creating outcomes and standards. They all were informed about the outcomes and standards only when they were included in educational policy and school practice, which is illustrated by some of the responses:

"*Teachers were given the right to vote after the implementation of outcomes and standards, then a public discussion was opened, but then, most of my colleagues and I did not want to comment*." (CTS1)

"*As far as I remember, it was only served to us as something ready, it was up to us to adhere to it, no one honestly asked us about our opinion, and even if they did so, it would only have been done pro forma*." (CTM1)

Based on these answers, the authors established that teachers were informed about the introduction of outcomes and standards, but believed that the process of defining and creating standards and outcomes should have been implemented differently.

"*Outcomes and standards should have been crafted by teachers who know what the real situation is in schools, not by someone who has no experience as a teacher*." (CTS2)

"*The people who are responsible for introducing outcomes and standards should be available to all teachers, to answer any questions that teachers have*." (CTS1)

Reasons for such teachers' perspectives could be changes in education policy without their active participation in creating reforms. The collected results regarding teachers' awareness of educational outcomes and standards and participation in the process of their implementation are in line with the results of prior studies.[4,38,39] Teachers worldwide generally feel disappointed because they do not have the opportunity to participate in the creation of standards and because their role is reduced to applying standards that are defined by educational policy makers. As mentioned, the findings of previous studies have shown that one of the ways to successfully overcome these problems is to involve teachers, „practitioners", in the process of designing standards, instead of just informing them that the standards have been defined and that their task is to apply them in the classroom.[30,40,41] Also, it is essential to address the quality of teacher instructors

because teachers demand well-trained instructors who can disseminate useful information about educational changes and transfer examples of good practice.[42]

Teachers' understanding of educational outcomes and standards

The second category of questions aimed to unveil teachers' comprehension of learning standards and outcomes. Moreover, this sub-section outlines teachers understanding of the importance of outcomes and standards and their opinion about their function and purpose. Some of the questions were related to the impact of outcomes and standards on lesson preparation and the usage of the outcomes and standards for monitoring student achievements.

All respondents acknowledged the significance of the outcomes and standards and their necessity for lifelong education. On questions about similarities and differences among outcomes and standards, teachers provided different answers, such as:

"*The standards are the framework that determines the lesson plans, while the outcomes are the goal that should be achieved by teaching, at the end of a certain period, such as one particular class.*" (CTM2)

"*Novice teachers can only learn to apply outcomes and standards properly after a few years, at the beginning it is tough, if not impossible*." (CTS1)

"*In my opinion, there should only be either standards or outcomes, in the end, both have the same function*." (CTM1)

Such teachers' opinions are not isolated, since the majority of teachers worldwide, find the implementation of outcomes and standards to be problematic and confusing.[38,43] Also, teachers expressed concerns about the amount of administrative work required for the teaching profession, which encompasses defining outcomes and standards and their operationalization.[44,45] These concerns are expected due to very broadly defined learning outcomes in the Serbian teaching curriculum.

All respondents viewed teachers as someone for whom educational standards and outcomes are intended. Some of them stated that through using educational standards and outcomes teachers can monitor the progress of each student as well as organize their lessons. Also, teachers confirmed that with outcomes and standards, they are able to improve their lessons and ensure better achievement of their students. One of the interesting answers was:

"*Educational standards and outcomes represent the roof of education, based on them the teacher can see how to build a house, how high and wide, and no house can be functional without a roof*." (CTS1)

They also mentioned the students and the school, as potential users of outcomes and standards, but pointed out that "*if the teacher adheres to the outcomes and standards properly, then the results achieved by the school are better*" (CTS1). The teacher's role in the process of accomplishing learning outcomes and standards is important and highlighted in a similar study.[46]

The teaching outcomes and standards eliminate uncertainties among teachers in evaluating students as well as give insight to students and their parents in the evaluation criteria. At the same time, it is easier to compare the marks between students from different schools when educational standards are defined at the national level. An overall positive response from teachers about the impact of educational outcomes and standards on students' achievements and organization of the teaching process is complementary with results of similar studies.[4,38,47]

Teachers' attitudes about the adequacy of educational outcomes and standards

This sub-section is related to the teachers' perceptions of the adequacy of educational standards and outcomes. The teachers were asked whether they think that the defined standards and outcomes are good or not, how useful they are, and as the most important item, whether education based on standards and outcomes adequately meets the needs of all students.

Summed teachers' opinions indicate the positive as well as negative sides of standards and outcome-based education. As a positive side, teachers stated that outcome-based education facilitated the planning and realization of teaching and improved monitoring of the progress of each student. The following several answers describe the downside of this form of education:

"*They are bad due to not following the development of society, science, the same has been taught for the last who knows how many years*." (CTS2)

"*The teaching process must be modernized, the defined standards and outcomes must be constantly revised, and the volume of material must be reduced*." (CTS1)

In earlier studies, teachers reacted differently when confronted with a new curriculum.[48] However, adequate support could contribute to the teachers' easy assimilation and accommodation with new pedagogies.[49] Also, there are plenty of examples of additional materials that show potential to improve the level of students' understanding, ability to think critically, and level of students' science literacy.[50,51] Experiences from countries where teaching standards have been part of educational policy for many years indicate that, for the acceptance of standards by teachers and the inclusion of standards in everyday teaching practice, it is also important how the standards are formulated.[52] Furthermore, it is important to understand them and that the way in which they are applied depends on whether the standards will be "*a good servant or an evil master*".[53]

Teachers' personal assessment of the implementation of outcomes and standards in teaching

In this research, the authors explored the teachers' self-assessment of their success in implementing the standards and outcomes. The teachers were asked about the knowledge and skills required for implementing education based on standards and outcomes. Furthermore, teachers' self-assessment of competence to

deal with the demands of outcomes-based education was examined. Also, ways of support that teachers see as essential for applying the concept of education based on standards and outcomes in school practice have been identified.

Some of the answers about self-success in the implementation of teaching based on educational standards and outcomes are given below:

"*I will be able to assess that at the end of education of one generation, after four years at least*." (CTS2)

"*I think that after so many years, I can successfully apply the outcomes and standards, and recognize what is most important for their achievement. Based on the results achieved by the students, I can say that I am on the right path*." (CTM1)

The first response in this sub-section is expected due to the fact one teacher from the sample is a novice, and, hence, in need of support and experience. The teachers believe that they can strengthen their knowledge and skills by constantly revising standards and outcomes and that they should constantly be trained to recognize what is most important for achieving outcomes and standards. On the question about the knowledge and skills required for implementing educational standards and outcomes, one of the teachers explained that "*no matter how many years a teacher works in education, no one is ever ready for all pedagogical situations that may occur in class, and hence, support is always welcome*" (CTS1). Also, teachers emphasized the need for defining correlation among subjects within outcomes and standards as an assistance for more efficient teaching.

"*Several teachers from different subjects should teach the same or similar material in the same time period, this should be acknowledged within outcomes and standards, not just with a verbal agreement between the teachers*." (CTS2)

Based on this, it can be concluded that teachers should also have the competence for cooperation with their colleagues. For successful teaching, with all the changes that are being introduced, it is necessary to strengthen the competencies of the teacher, both the competencies for cooperation with students and for cooperation with other teachers.[54]

Regarding the competencies that need to be strengthened, all of them cited ICT (Information and Communication Technologies) competencies. This finding overlaps with other natural sciences teachers' opinions and indicates that teachers are interested in the opportunities offered by ICT.[55] ICT learning tools can be useful for understanding many chemical phenomena. Thus, teachers need adequate support from schools and faculties to use technology in teaching through different pedagogical and technical trainings.

Analysis of the students' achievements on the knowledge test

The data collected with the knowledge test are presented in Table I. The students' achievements on the knowledge test were presented to chemistry teachers and interpreted in tandem with them.

TABLE I. Distribution of answers (%) on the knowledge test

Question No. (Table S-III)	Answer							
	Correct		Partially correct		Wrong		Without answer	
	GS[a]	GM[b]	GS	GM	GS	GM	GS	GM
1	12.4	21.7	73.0	61.4	14.6	14.5	-	2.4
2	10.1	16.9	-	-	-	-	89.9	83.1
3	82.0	81.9	18.0	14.5	-	-	-	3.6
4	68.5	69.9	31.5	30.1	-	-	-	-

[a] GS-Grammar school from Serbia; [b] GM-Grammar school from Montenegro

The first question investigated whether students know how to classify lipids depending on their structure. Based on the given chemical representations, students needed to determine which listed lipids could be saponified. In both grammar schools, students did not show satisfactory knowledge about the structure of lipids. In Serbia, out of a total of 89 students, only 12.4 % of them (11 students) answered correctly, whereas that number was similar in Montenegro, 21.7 % (18 students) of a total of 83 students. Chemistry teachers point out that throughout the elaboration on this topic, they paid little attention to the structure of phospholipids, terpenes, and other lipids, whilst they focused on fats and oils. Furthermore, they justify the above-mentioned result with the insufficient number of classes and short class duration. The teacher from Kragujevac especially highlights the period of elaboration on this topic (April/May) as a cause of the low number of correct answers, as during these months students are more focused on preparation for faculty entrance exams. The majority of students partially answered this question correctly and circled only the answer *c)*. A small number of students circled the answer *a)* and not the answer *c)*.

The second question examined students' knowledge of physical properties of lipids. Students were supposed to give an adequate explanation of the solvation of fatty acids based on their structure. This question had the lowest number of correct answers, in both countries. Based on the obtained data, it can be seen that the majority of students did not attempt to answer this question. The teacher from Montenegro stated that he did not require students to know this explanation, whereas the teachers from Serbia the low percentage of correct answers explained in the same way as in regard to the previous question, and they pointed out students' lack of interest. Based on correct answers, it can be concluded that this content does not have to be abstract for students, it is only important to connect the

previously acquired knowledge with the new one. As an illustration of the previous statement, the authors list the following answers:

"*A large hydrocarbon chain is non-polar, so fatty acids dissolve in non-polar solvents and not in water*." and "*Fatty acids do not dissolve in water because of their non-polarity*."

With the third question, the authors examined whether students know basic chemical concepts related to real life. Students were asked to state the roles of fats and oils in human organism, as well as to name food sources that are rich in fats and oils. This question had the highest number of correct answers (in both grammar schools over 80 % of students). It should be pointed out also that none of the students answered incorrectly to this question. Mostly, students cited an energetic role, but a majority of students marked also a thermoregulatory role of fats and oils. Almost all students listed food sources that are rich in fats and oils (bacon, cheese, seeds, salmon, flax, almonds, avocados, dairy products, cream, fish oil, butter, fish, nuts, etc). On the other hand, some of them did not mention the role of fats and oils in the human body, and, hence, such answers are accepted as partially correct. This result could relate to the abundance of the respective compounds in everyday life. Food packages contain this information, and this topic is often discussed in the media and their social environment. One of the teachers states that this was an "*easy question*", because as she says, "*as prom night celebration draws nearer, most students go to the gym and know how much they can take into their body, what role food plays in their body, as well as how it affects their weight*" (CTS1).

The fourth question is an extension of the previous question. The authors were interested in whether the students could explain why polar bears survive at extremely cold temperatures. About 70 % of students answered this question correctly (in Serbia 68.5 % and in Montenegro 69.9 %), stating that the thermoregulatory role of fat in animal organism is responsible, as well as the role of fat as a heat insulator. Answer such as the following: "Because of the large layer of fat" and similar, are accepted as partially correct, due to this response being correct in a certain way but unspecified. None of the students left the question unanswered or answered incorrectly.

The following figure (Fig 1) presents the percentages of correct answers of students from both grammar schools on each of the four questions in the knowledge test.

Fig 1. Distribution of respondents' correct answers to questions per grammar school;

red - Grammar school, Serbia and blue - Grammar school, Montenegro

The figure above (Fig 1) suggests that for the two questions (1st and 2nd), defined learning outcomes do not exceed 25 % of achievement among students.

On the other hand, outcomes on which questions number 3 and 4 were accomplished by nearly 80 % of students. The level of achieved learning outcomes concerning the structure and properties of lipids is concerning and needs improvement, in contrast to accomplished outcomes about the role and importance of lipids for the living world. Students from the Montenegrin grammar school show somewhat better results but overall there is no significant difference between the results of students from two states.

The collected data by a knowledge test could relate to earlier similar research that examined the level of achievement standard. Respective research included not only grammar schools but also vocational school students and indicated better achievements among vocational school students, hence, a lower level of accomplished outcomes among students from the two grammar schools could be expected.[56] Through the preparation of the knowledge test, teachers already knew which questions students would and would not be able to answer correctly. Some reasons cited were that they did not ask the students to know certain content, while for other content, even though it is defined by the plan and program, there is not enough time and classes during one school year. According to the present and other prior research, the teachers are links between the defined outcomes and the students.[57] The teachers also state that the students did not give correct answers to certain questions as majority of them do not want to study, they lack interest, and if some students learn even the basic things it is a success. There is a study with similar answers from their respondents.[58] As a problem in the realization of evaluating student achievements, the teachers state that the students are not motivated to work in class, they do not have sufficiently developed work habits, they are not focused on what the teacher presents during the class, and the main problem is that the students learn only to get the desired grade.

CONCLUSION

The conducted study aimed to explore the teachers' attitudes toward educational outcomes and standards in the two countries, Serbia and Montenegro, as well as to assess the level of students' accomplished outcomes for the teaching topic „Lipids“. The key findings of this research can be summarized as follows. Although research included teachers from two educational systems, Serbian and Montenegrin, there are no significant differences in their attitudes and perspectives. They all point out that it is essential to take into consideration teachers’ opinions about implementing educational changes, and thus, make reforms more realistic and easier to implement in everyday school practice. Otherwise, teachers may not consider themselves potential leaders in the process of changing contemporary educational practices. Teachers from both grammar schools emphasize the importance of learning outcomes and standards and affirm that they help them in organizing lessons and monitoring students' assessments. It

is important to support teachers in their demands referring to constant revising of standards and outcomes, defining correlation among subjects within outcomes and standards, reinforcing ICT competencies, etc., all in service to more efficient teaching.

The results gathered from the knowledge test have highlighted that knowledge about „Lipids“ among students is not on an enviable level. Responses obtained show that students recognize the importance of chemistry and lipids in everyday life, and their presence in diet and environment. On the other hand, percentage of correct answers was lower on questions related to the physical properties of fats and oils, and their structure. There are no significant differences in achieved accomplishments between students from two countries, Serbia and Montenegro. There could be plenty of reasons for that, similar curriculum, teachers' initial education, pandemic effects and online learning, the individual characteristics of both, teachers and students and the quality of the teaching process. Collected data are in disagreement with teaching curriculum and defined outcomes, and imply the need to make some changes in the two educational systems. Above all, learning activities that promote knowledge acquisition need to be developed. This result can trigger the educational community to inspect the existing curriculum and bring adequate changes to it. The teaching curriculum needs to be innovative and it has to take into account new discoveries, students' needs and the needs of society as well as support students in their professional development.

SUPPLEMENTARY MATERIAL

Additional data are available electronically at the pages of journal website: https://www.shd-pub.org.rs/index.php/JSCS/article/view/12747, or from the corresponding author on request.

Acknowledgements: This work was supported by the Serbian Ministry of Science, Technological Development, and Innovation (Agreement No. 451-03-47/2023-01/200122).

И З В О Д

ОБРАЗОВНИ ИСХОДИ И СТАНДАРДИ ЗА ПРЕДМЕТ ХЕМИЈА У СРБИЈИ И ЦРНОЈ ГОРИ. АНАЛИЗА СТАВОВА НАСТАВНИКА И ПОСТИГНУЋА УЧЕНИКА

ФИЛИП СТАШЕВИЋ[1], АНДРЕА БУБАЊА[2], АЛЕКСАНДРА МАКСИМОВИЋ[1] И ЈЕЛЕНА ЂУРЂЕВИЋ НИКОЛИЋ[1]

[1]Универзитет у Крагујевцу, Природно–математички факултет, Радоја Домановића 12, 34000 Крагујевац, Србија и [2]Гимназија „Панто Малишић“, Берансело VIII/6, 84300 Беране, Црна Гора.

Реформе у образовању су уобичајена појава и захтевају детаљну анализу. Реализација образовања заснованог на стандардима и исходима довела је до прилагођавања школа и наставног процеса и остваривања професионалног идентитета наставника. Ово истраживање је имало за циљ да испита ставове наставника хемије у контексту примене образовних исхода и стандарда, као и да открије ниво остварених исхода учења за одабрану наставну тему „Липиди“. Истраживањем су обухваћени и наставници хемије (N=4) и ученици гимназија (N=172) из две земље, Србије и Црне Горе. Подаци су квантитативно и

квалитативно анализирани коришћењем миксметодског приступа истраживања и константног поређења података. Анализом резултата уочено је да нема значајних разлика у ставовима наставника, као ни у постигнућима ученика између две земље. Сви наставници су истакли значај исхода учења и стандарда постигнућа и потврдили да им помажу у организовању часова и праћењу оцењивања ученика. Међутим, истакли су захтеве за подршку и уважавање мишљења наставника о спровођењу образовних реформи. Резултати са теста знања су показали да знање о „Липидима“ код ученика није на очекиваном нивоу.

(Примљено 27. децембра 2023; ревидирано 21. фебруара 2024; прихваћено 9. јула 2024.)

REFERENCES

1. A. Hargreaves, A. Lieberman, M. Fullan, D. Hopkins, *Second International Handbook of Educational Change*, Springer, Berlin, Germany, 2009 (https://doi.org/10.1007/978-90-481-2660-6)
2. D. K. Cohen, H. C. Hill, *Learning policy: When state education reform works*, Yale University Press, New Haven, United States, 2001
3. D. A. Spencer, *Educ. Res.* **25** (1996) 15 (https://doi.org/10.2307/1177154)
4. J. Radišić, J. Raković, N. Pantić, J. Marković, A. Maksimović, M. Marković, (2012). *Teachers as proponents and opponents of education reforms – the case of Serbia*, in *Research, Policy and Practice in Teacher Education in Europe*, J. Madalinska-Michalak, H. Niemi, S. Chong Ed(s)., University of Lodz, Lodz, Poland. 2012, p. 223
5. P. Rado, *Governing Decentralized Education Systems: Systemic Change in South Eastern Europe*, Open Society Foundations, Budapest, Hungary, 2010
6. L. J. Dull, *Comp. Educ. Rev.* **56** (2012) 511 (https://doi.org/10.1086/664993)
7. The national core curriculum for general education, Ministry of Education and Sports, Belgrade, Serbia, 2003
8. Curriculum for the first grade of compulsory education and upbringing (10/2017-1, 12/2018-1), Official Gazette, Belgrade, Serbia, (https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/eli/rep/pg/ministarstva/pravilnik/2017/10/1/reg) (6.11.2023.) (in Serbian)
9. Curriculum for the fifth grade of compulsory education and upbringing (15/2018), Official Gazette, Belgrade, Serbia, (https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/eli/rep/pg/ministarstva/pravilnik/2018/15/2/reg) (6.11.2023.) (in Serbian)
10. Curriculum for the general secondary education and upbringing (12/2018), Official Gazette, Belgrade, Serbia, (https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/eli/rep/pg/ministarstva/pravilnik/2017/10/1/reg) (6.11.2023.) (in Serbian)
11. General standards of achievement for the end of compulsory education, Institute for the Evaluation of the Quality of Education, Belgrade, Serbia, 2009 (in Serbian) (https://ceo.edu.rs/стандарди-у-образовању/) (6.11.2023)
12. General standards of achievement for the end of the first cycle of compulsory education, Institute for the Evaluation of the Quality of Education, Belgrade, Serbia, 2011 (in Serbian) (https://ceo.edu.rs/стандарди-у-образовању/) (6.11.2023)
13. General standards of achievement for the end of general secondary education and upbringing and secondary vocational education and education in the field of general education subjects for the subject - Chemistry, Institute for the Evaluation of the

Quality of Education, Belgrade, Serbia, 2013 (in Serbian) (https://ceo.edu.rs/стандарди-у-образовању/) (6.11.2023)
14. Z. Lalović, Assessment in the function of student development and improvement of teaching and learning in school, Institute for Education, Podgorica, Montenegro, 2020 (ISBN 978-9940-24-078-3) (in Serbian)
15. V. Mićanović, *J. Elem. Educ.* **12** (2019) 245 (https://doi.org/10.18690/rei.12.3.245-265.2019)
16. Work report for 2019 (01/1-077/20-122/1), Institute for Education, Podgorica, Montenegro, 2020, (https://wapi.gov.me/download-preview/8139a44a-aced-4b5e-a43b-66d2a6408ff4?version=1.0) (8.4.2024) (in Serbian)
17. Work report for 2020 (01/1-077/21-99/1), Institute for Education, Podgorica, Montenegro, 2021, (https://wapi.gov.me/download/d3cc484f-58ce-400b-89ba-4076a1eb2eb1?version=1.0) (8.4.2024) (in Serbian)
18. Institute for the Improvement of Education and Training, Ministry of Education, Science and Innovation (150-00-6/2016-06) (https://zuov.gov.rs/obuka-za-realizaciju-nastave-orijentisane-ka-ishodima-ucenja-21-11-2022-godine/) (8.4.2024.) (in Serbian)
19. Institute for the Improvement of Education and Training, Ministry of Education, Science and Innovation (150-00-6/2016-06) (https://shorturl.at/uwAI2) (8.4.2024.) (in Serbian)
20. Professional program catalog teacher trainings for the school year 2019/20 and 2020/21, Institute for Education, Podgorica, Montenegro, 2019, (https://profesionalnirazvoj.edu.me/2024/01/23/katalozi-programa-strucnog-usavrsavanja-nastavnika-ca/) (8.4.2024.) (in Serbian)
21. Referencing the Montenegrin Qualifications Framework to the European Qualifications Framework for Lifelong Learning and the Qualifications Framework for the European Higher Education Area, Ministry of Education, 2014 (https://europa.eu/europass/system/files/2020-06/Montenegrin%20Referencing%20Report.pdf) (13.11.2023.)
22. B. Tomašević, D. Trivić, S. Bojović, *Pedagogija*, **63** (2008) 261
23. A. Maksimović, *Nastava vasp.* **65** (2016) 279 (https://doi.org/10.5937/nasvas1602279m)
24. D. Trivić, R. Jankov, M. Ranđelović, M. Marković, G. Zindović-Vukadinović, *Nastava vasp.* **56** (2007) 30
25. D. Trivić, R. Jankov, M. Ranđelović, V. Vukotić, M. Marković, R. Kovačević, M. Nikolić, *Educational standards for the end of compulsory education for the subject - chemistry, Ministry of Education*, Science and Technological Development of the Republic of Serbia, Belgrade, Serbia, 2010 (ISBN 978-86-86715-22-7) (in Serbian)
26. Curriculum for the fourth grade of general secondary education and upbringing, Institute for Education, Podgorica, Montenegro, 2020, (https://www.gov.me/dokumenta/0b6e9e24-768e-4237-a5c7-4e1434cfc992) (8.4.2024.) (in Serbian)
27. Examination center, Ministry of Education, Science and Innovation, (https://iccg.co.me/) (8.4.2024.) (in Serbian)
28. A. Maksimović, *Inov. Nastavi* **30** (2017) 98 (https://doi.org/10.5937/inovacije1702098M)

29. N. Havelka, E. Hebib, A. Baucel, *Assessment for Student Development: A* Handbook *for Teachers*, Center for evaluation of quality in education and upbringing, Belgrade, Serbia, 2003 (in Serbian)
30. A. Pešikan, *Inov. Nastavi*, **25** (2012) 5 (http://www.inovacijeunastavi.rs/wp-content/uploads/arhiva/2012/Inovacije-1-12.pdf)
31. S. J. Ball, *J. Educ. Policy* **18** (2003) 215 (https://doi.org/10.1080/0268093022000043065)
32. OECD Reviews of Evaluation and Assessment in Education: Serbia (https://www.oecd-ilibrary.org/sites/72483fab-en/index.html?itemId=/content/component/72483fab-en) (13.11.2023.)
33. R. B. Johnson, A. J. Onwuegbuzie, *Educ. Res.* **33** (2004) 14 (https://doi.org/10.3102/0013189X033007014)
34. V. Braun, V. Clarke, *Qual. Res. Psychol.* **3** (2006) 77 (https://doi.org/10.1191/1478088706qp063oa)
35. S. B. Merriam, *Qualitative research and case study applications in education*, Jossey-Bass, San Francisco, United States, 1998
36. A. Hargreaves, P. Woods, *Classrooms and Staffrooms: The Sociology of Teachers and Teaching*, Routledge, London, United Kingdom, 1984 (https://doi.org/10.4324/9780367823221)
37. T. Ferguson, C. Roofe, L. D. Cook, *Environ. Educ. Res.* **27** (2021) 1343 (https://doi.org/10.1080/13504622.2021.1921113)
38. A. Maksimović, I. Ćosić, *Psihološka istraživanja*, **22** (2016) 189 (https://doi.org/10.5937/PSISTRA22-20024)
39. J. Pieters, J. Voogt, N. P. Roblin, *Collaborative Curriculum Design for Sustainable Innovation and Teacher Learning*, Springer, Berlin, Germany, 2019 (https://doi.org/10.1007/978-3-030-20062-6)
40. D. Stanković, I. Đerić, V. Milin, *J. Inst. Educ. Res*. **45** (2013) 86
41. N. Vujisić Živković, J. D. Vranješević, *Inov. Nastavi* **32** (2019) 13 (https://doi.org/10.5937/inovacije1903013V)
42. J. Teodorović, D. Stanković, B. Bodroža, V. Milin, I. Đerić, *Educ. Assess. Evaluation Account.* **28** (2016) 347 (https://doi.org/10.1007/s11092-015-9221-x)
43. D. Malinić, Đ. Komlenović, J. Stanišić, *Nastava Vasp.* **62** (2013) 576
44. S. Horvat, V. Popović, D. Rodić, T. Rončević, *J. Serb. Chem. Soc.* **88** (2023) 793 (https://doi.org/10.2298/JSC220822039H)
45. B. Tomašević, D. Trivić, *Pedagogija* **4** (2014) 605
46. V. F. Savec, B. Urankar, M. Aksela, I. Devetak, *J. Serb. Chem. Soc.* **82** (2017) 1193 (https://doi.org/10.2298/JSC161221083S)
47. Đ. Komlenović, D. Malinić, J. Stanišić, *Nastava vasp.* **63** (2014) 401
48. R. Dolfing, A. Bulte, A. Pilot, J. D. Vermunt, *Res. Sci. Educ.* **42** (2012) 567 (https://doi.org/10.1007/s11165-011-9211-z)
49. R. Dolfing, G. T. Prins, A. M. W. Bulte, A. Pilot, J. D. Vermunt, *Sci. Teach. Educ.* **105** (2020) 127 (https://doi.org/10.1002/sce.21603)
50. J. Korolija, S. Rajić, M. Tošić, Lj. Mandić, *J. Serb. Chem. Soc.* **80** (2015) 1567 (https://doi.org/10.2298/JSC150522072K)
51. K. Putica, D. D. Trivić, *Chem. Educ. Res. Pract.* **17** (2016) 172 (https://doi.org/10.1039/C5RP00179J)
52. V. Klenowski, *Oxf. Rev. Educ.* **39** (2013) 36 (https://doi.org/10.1080/03054985.2013.764759)

53. A. Baucal, *Inov. Nastavi* **26** (2013) 7 (http://www.inovacijeunastavi.rs/wp-content/uploads/Inovacije3-13/01-Baucal.pdf)
54. N. Zobenica, A. Stipančević, *Pedagoška stvarnost* **63** (2017) 107 (https://doi.org/10.19090/ps.2017.2.107-119)
55. M. Aksela, J. Lundell, *Chem. Educ. Res. Pract.* **9** (2008) 301 (https://doi.org/10.1039/B818464J)
56. F. Stašević, N. Miletić, J. Đurđević Nikolić, I. Gutman, *J. Serb. Chem. Soc.* **88** (2023) 343 (https://doi.org/10.2298/JSC211126083S)
57. H. C. Hill, M. Chin, *Am. Educ. Res. J.* **55** (2018) 1076 (https://doi.org/10.3102/0002831218769614)
58. B. Tomašević, K. Putica, D. Trivić, *Hemijski pregled* **57** (2016) 99.