

## DISTANCE TEACHING OF CHEMISTRY DURING THE COVID-19 PANDEMIC: CHALLENGES AND SOLUTIONS <sup>a</sup>

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### Abstract

The aim of this paper was to examine the opinion of chemistry teachers on distance learning realized during the COVID-19 pandemic in the period from March 17 to June 15, 2020. The sample includes 75 primary and secondary school chemistry teachers. The results show that the third of teachers and students followed the teaching contents in chemistry that were broadcast on the channels of the Public Media Service of Serbia. Most teachers realized distance learning using the Google classroom, using teaching materials that they created in the form of presentations, videos and tests, while communication with students and parents was mostly reduced to Viber and social networks. Chemistry teachers had difficulties during the planning and preparation of teaching materials, but also during the assessment which, in the opinion of most teachers, was not objective. The paper presents the suggestions of teachers in order to improve the assessment process. The general attitude and satisfaction of chemistry teachers about the realized teaching is divided - while some teachers are very satisfied, others are dissatisfied. Chemistry teachers have clearly pointed out the need for professional training in the field of making materials for distance learning, working with software and platforms for the implementation of teaching itself, but also in the field of methodological training and preparation for distance learning.

**Key words:** chemistry teaching, teacher opinions, Covid-19, assessment, distance learning

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## НАСТАВА ХЕМИЈЕ НА ДАЉИНУ ТОКОМ ПАНДЕМИЈЕ КОВИД-19 – ИЗАЗОВИ И РЕШЕЊА

### Апстракт

Циљ овог рада био је испитивање мишљења наставника хемије о настави на даљину реализованој током пандемије ковид-19 у периоду од 17. марта до 15. јуна 2020. године. У истраживању је учествовало 75 наставника хемије основних и средњих школа. Резултати су показали да је трећина наставника и ученика пратило наставне садржаје из хемије који су емитовани на каналима Јавног медијског сервиса Србије. Највише наставника је реализовало наставу на даљину користећи Гугл учионицу и примењујући наставне материјале које су сами израђивали у форми презентација, видео материјала и тестова док је комуникација са ученицима и родитељима у највећој мери сведена на Вибер и друштвене мреже. Наставници хемије су имали потешкоће током планирања и припреме наставних материјала, али и током оцењивања које, по мишљењу већине наставника, није било објективно. У раду су приказани предлози наставника како би се могао побољшати процес оцењивања. Генерални став и задовољство наставника хемије о реализованој настави је подељено – док је део наставника веома задовољан, други део је незадовољан. Наставници хемије су јасно указали на потребу за стручним усавршавањем у области израде материјала за потребе наставе на даљину, рада са софтверима и платформама за реализацију саме наставе али и у области методичке обуке и припреме за наставу на даљину.

**Кључне речи:** настава хемије, мишљења наставника, ковид-19, оцењивање, настава на даљину

### INTRODUCTION

The outbreak of the coronavirus virus in 2019, which quickly turned into a global pandemic of Covid-19, had a serious impact on education. Many countries closed schools, colleges and universities as one way to protect the population from possible disease risks. During the pandemic, different countries around the world introduced different solutions to continue the education process.

Broadcasting of teaching content on television channels that reach the largest number of students with the use of online libraries, online channels and video lectures has been applied in at least 96 countries around the world (Basilaia & Kvavadze, 2020). Some innovative solutions have been proposed for distance learning, such as the flipped classroom, asking online questions, video conferencing instead of live lectures, using simulations and videos (Chick, et al., 2020). In some countries, distance learning has been implemented using a synchronous strategy, which includes asking questions and giving answers in real time, and an asynchronous strategy, which includes presentations with audio recordings, tests and tasks (Villanueva et al., 2020). Obviously, the availability of digital tools, devices, and virtual programs, as well as previous experiences and teacher training to implement distance learning pro-

grams, were a great help during the Covid-19 pandemic (Dominici, 2020).

The scientific literature dealing with distance learning during the Covid-19 pandemic is growing daily. Different authors present their experiences and the experiences of others in order to provide the most comprehensive solutions for the most effective online teaching.

#### *Teaching in Serbia during the Covid-19 Pandemic*

In the Republic of Serbia, as in most countries around the world, teaching during the emergency situation caused by the Covid-19 pandemic was realized by broadcasting teaching content on the channels of the Public Broadcasting Service of Serbia. In this way, continuity in student education was ensured. Lectures were recorded and classes were taught for primary and secondary school students, including classes prepared for the final exam, as well as classes dedicated to the analysis of tasks within the self-assessment of knowledge and the trial final exam. Classes were broadcast according to a predetermined schedule for the first and second cycles, and each class lasted from 25 to 30 minutes (Ministry of Education, Science and Technological Development of Republic of Serbia, 2020).

The classes were recorded following the curricula of a given course, prepared by the Institute for the Advancement of Education, as the institution responsible for the preparation of curricula and syllabi. Distance learning was conceived as a combination of TV teaching, interaction of teachers and students through different platforms and the applications and independent learning of students. So, simultaneously with the broadcasting of the teaching content on television channels, the schools organized distance learning educational activities for their students in accordance with the instructions of the Ministry. At the *mojaskola.gov.rs*, the national platform for online learning was established, which followed the classes broadcast on RTS and where interactive tests were introduced (Ministry of Education, Science and Technological Development of Republic of Serbia, 2020).

#### *Chemistry Education during the Covid-19 Pandemic*

The implementation of chemistry teaching during the Covid-19 pandemic presents a unique challenge to teachers due to the nature of the subject itself. In chemistry, experiment is the basic form of cognition and, as such, it is an indispensable form of learning and teaching chemistry, regardless of the way in which the teaching is organized. Some authors suggested that students should be offered experiments that can be performed at home, using only safe household items and substances, without special equipment. (Andrews et al., 2020; Selco, 2020). Andrews et al.

(2020) designed school experiments in general chemistry that include content on pH, buffers, acid-base titrations, solubility, chemical equilibrium and thermodynamics.

Although there is no substitute for experiential learning, the application of virtual laboratories is an effective way to alleviate the shortcomings of online chemistry teaching. Moreover, the use of virtual laboratories overcomes some of the problems that students and teachers face during experimental work, for example working with toxic substances, very expensive substances, performing experiments that are time consuming, that require special equipment, etc. (Tüysüz, 2010). Examples of virtual laboratories and the possibility of their application are described in numerous papers (Boschmann, 2003; Holden, & Kurtz, 2001; Dalgarno et al., 2009; Tüysüz, 2010; Tatli, & Ayas, 2013). A significant fact and limiting factor for many chemistry teachers from Serbia is that most of the interactive tools and software related to virtual chemistry laboratories and chemical simulations are in English.

At the time of the Covid-19 pandemic, there were a number of free resources available on several websites. Many of them were provided by the American Chemical Society, Department of Chemical Education (Dominici, 2020). The same association launched a special issue of the *Journal of Chemical Education* with the aim of sharing best practices in chemical education on distance learning and teaching during the state of emergency (Holme, 2020). Other associations, such as the Royal Society of Chemistry of the UK and the Italian Chemical Society have also started exchanging experiences from the chemical laboratory and free resources for online teaching (Dominici, 2020).

In order to find the best solution for online chemistry teaching, synchronous, asynchronous or combined strategies were applied (Dominici, 2020; Villanueva et al. 2020; Sunasee, 2020). Chemistry teachers in high schools and universities mostly used the synchronous strategy and applied video lessons that they mostly prepared themselves, without the help and cooperation of other teachers, schools or the university system. Most of these activities were realized on learning platforms, such as Moodle, or on web pages designed for video conferencing (Google Meet, Microsoft Teams, Zoom, Skype, etc.) (Dominici, 2020).

Research examining the effectiveness of teaching materials in online teaching of analytical chemistry has shown that, during the delivery of the synchronous face-to-face lessons, the main weakness of this strategy was the lack of a good Internet connection. On the other hand, asynchronous lessons did not require a very good Internet connections and students were able to stop the lessons and continue learning later. However, the lack of interaction between students and teachers was the main problem of this type of communication. Most teachers pointed out that the combination of synchronous and asynchronous forms of commu-

nication is desirable for analytical chemistry classes from the application of any of them separately (Villanueva et al. 2020).

Sudden change in the way of teaching and the transition to distance teaching required teachers to quickly acquire new knowledge. As a result, there has been an exponential increase in the exchange of experiences between teacher groups on social media, which has generated thousands of posts and comments on ways to adapt chemistry teaching for distance learning (DeKorver, Chaney, & Herrington, 2020). Many chemistry teachers began to record and share their own video lessons, videos of practical work and laboratory experience, performed at home using common materials from everyday life (Dominici, 2020).

In the paper by Pearson (2002), the authors examined the use of crossword puzzles after a distance lecture during the Covid-19 pandemic to help revise chemistry material in first- and second-year students. The results showed that students accepted crossword puzzles as a form of active learning, that they found them useful and that it was desirable to apply them more in teaching (Pearson, 2020).

Knowledge assessment during distance learning is a special challenge that includes the creation of tests or other forms of knowledge testing, as well as the implementation of the assessment process itself. The results so far show that the possibility of cheating on tests can be reduced if a series of steps are taken. First, the knowledge test needs to be conducted at a scheduled time with limited duration. In this manner, if the students communicate with each other, the time for completing the assignments is reduced. Secondly, repositories of questions should be made with variants of similar questions in order for the tests to be different for each student. Furthermore, it is necessary to apply appropriate remote assessment software, for example Proctorio9 which makes a video of each student, indicates suspicious behavior and prevents the opening of multiple windows and browsers (Lewis, 2020).

Based on the review of available literature, different efforts of teachers to find the most efficient way to implement distance learning and assessment of acquired knowledge can be noticed. This paper aims to show how chemistry teachers in Serbia have implemented distance learning and assessment, what problems and challenges they have encountered, what has been done successfully and what could be improved.

### *METHODOLOGY*

After the closure of schools with the aim of preventing the spread of the coronavirus, distance learning was a way to provide students with continuity of education. However, little is known about the effectiveness of such teaching, the challenges faced by teachers and students, as well as their parents. The research was conducted with the aim of examining the

opinions of chemistry teachers about distance learning realized during the Covid-19 pandemic. The conducted research included the following specific research goals:

1. to examine which teaching materials and software were used by teachers during distance learning.
2. to examine how teachers prepared for distance learning.
3. to examine how teachers communicated with students and other teachers.
4. to examine opinions of teachers on student assessment during distance learning.
5. to examine opinions of teachers about their online teaching competencies and need for professional development.
6. to examine opinions of teachers on how satisfied they and their students are with the realized distance learning.

#### *Participants and Procedure*

The study involved the total of 75 chemistry teachers with work experience in schools from 1 to 25 years ( $M = 14.72$ ,  $SD = 4.44$ ), employed in primary schools, high schools or secondary vocational schools. Most teachers were from the territory of Vojvodina. The sample consisted of 13.5% of male respondents, and 86.5% of female respondents, and the remaining 13.5% of respondents did not want to declare their gender identity. The survey was conducted online using a Google questionnaire during June 2020. Participants completed the questionnaire voluntarily and anonymously. At the beginning of the questionnaire, they were informed about the purpose of the research and the possibility to give up further participation in the research at any time.

#### *Instrument*

For the purpose of this research, a questionnaire was constructed. It contained 28 questions given in the form of multiple-choice questions with the possibility of adding explanations and other information to the answers. This form of questionnaire was chosen in order to have a more comprehensive view of the teachers' opinions and problems they encountered during distance learning.

### *RESULTS AND DISCUSSION*

#### *Teaching Materials and Software Applied during Distance Learning*

As a part of the first research goal, it was examined to what extent chemistry teachers and students followed chemistry classes that were broadcast on the channels of the Public Media Service - RTS channel 2, RTS channel 3 and RTS Planet in the period from March 17 to June 15,

2020. Almost a third of the teachers included in this research (32.4%) stated that students regularly attended these classes, 39.2% of teachers believe that students did not follow this content, while the remaining teachers (28.4%) said that they did not know. Most of the surveyed teachers also watched the broadcast classes (41.9% regularly and 48.6% occasionally). There is an agreement among teachers that this form of teaching is not enough for students to fully understand the material on chemistry (95.9%). This result is expected and justified because distance learning is designed as a combination of TV teaching, interaction between teachers and students through different platforms and applications and independent learning of students (Ministry of Education, Science and Technological Development of Republic of Serbia, 2020).

The majority of teachers (83.8%) pointed out the problem of inconsistency between teaching units broadcast on television and their operational work plans. More than half of the teachers (62.2%) pointed out that the pace of the broadcast classes was too fast and there was not enough time to practice, repeat and review. One of the problems that caused the inconsistency of the broadcast shows with the operational plans of teachers is very objective - the broadcast shows were intended for students from all of the Republic of Serbia, and the work calendars for Vojvodina and the rest of Serbia differ. This reason was stated by 21.6% of surveyed teachers. Although the curriculum that was recorded was in accordance with the programs of teaching and learning a certain subject, certain changes had to exist, since the classes ended earlier than the planned end of the school year 2019/2020 (Ministry of Education, Science and Technological Development of Republic of Serbia, 2020).

Different authors define the concept of distance learning in different ways. Common to all definitions is that some form of teaching takes place between two parties (instructors and students) and it takes place in different places and/or at different times using different teaching materials (Moore, Dickson-Deane, & Galyen, 2011). Therefore, this research examined which teaching materials were used by chemistry teachers and how they were distributed to students during distance learning.

Half of the teachers (50%) used materials they made themselves. A smaller part of teachers used materials from RTS Planet and materials they downloaded from the Internet (22.2%), while the smallest number of teachers (5.6%) used materials obtained from colleagues. Chemistry teachers stated that they, among the different types of teaching materials, mostly used presentations, video materials and tests. They used text documents, sound recordings and screencasts to a lesser extent, while podcasts, images, diagrams and charts were used the least. They also did little to refer students to online content such as YouTube videos and the like (Figure 1).

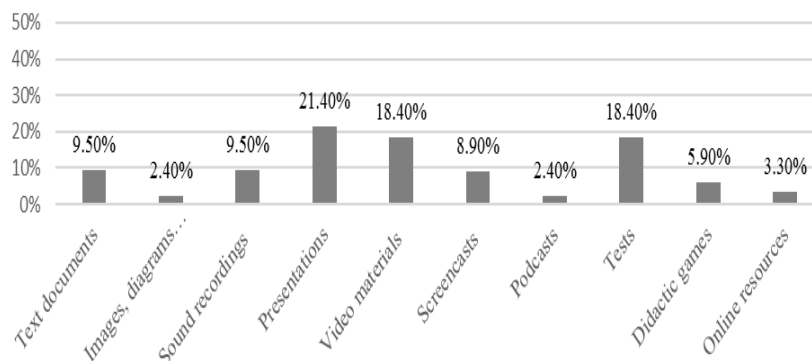


Figure 1. Teaching materials used during distance teaching

Most teachers used the Google classroom during distance teaching, which is one of the best platforms of its kind since it allows participants to communicate with each other, watch presentations, videos, communicate with other participants and be engaged in various activities (Iftakhar, 2016). A small number of teachers (2.7%) used Edmodo while only 1.4% applied Microsoft Teams, Viber, Socrative, etc. An interesting result is that 9.5% of teachers stated that they did not use any platform or application in distance teaching (Figure 2). The question remains as to how they implemented distance learning.

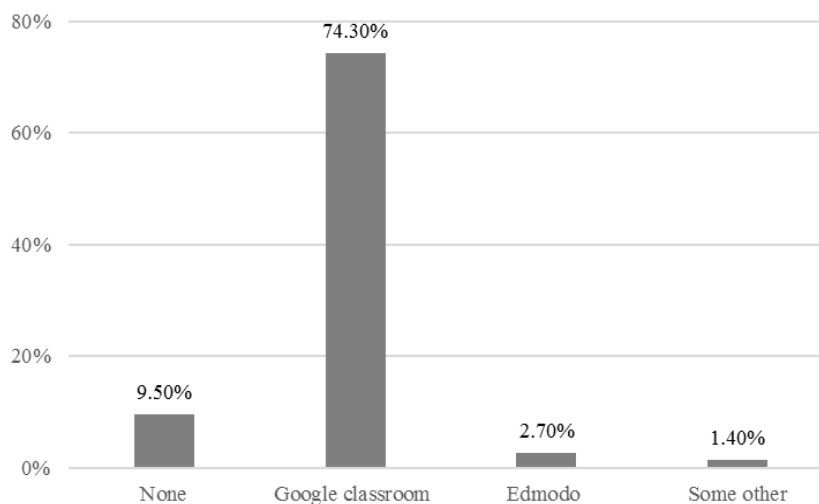


Figure 2. Platforms applied in distance teaching

Based on these results, it can be concluded that chemistry teachers in the Republic of Serbia moderately used platforms intended for distance

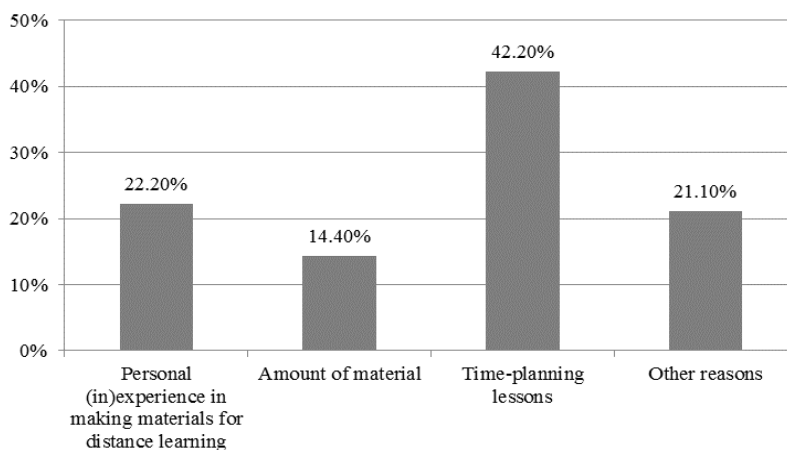


learning in comparison to the chemistry teachers in other countries who realized most of their activities on learning platforms such as Moodle or on websites designed for video conferencing (Google Meet, Microsoft Teams, Zoom, Skype etc.) (Dominici, 2020).

#### *Examining the Way Teachers Prepared for Distance Learning*

The second research task was to examine the teachers' ways to prepare themselves for distance teaching. Within this task, teachers were asked about the time invested in preparation and activities they undertook. Most teachers (81.1%) needed more time to prepare and teach at distance than to prepare and teach regular classes. Only 1.4% of teachers estimated that they needed less time for distance teaching, while the rest of the teachers (17.5%) estimated that they needed equal time for preparation for both regular and online classes.

During the preparation for distance teaching, teachers faced numerous difficulties (Figure 3). The majority of teachers (42.2%) stated that they had difficulties in time-planning lessons because students were not included in the discussion. About 20% of the surveyed teachers stated that the problems in the preparation of materials and the time for their preparation are the result of their (in)experience in making materials for distance learning. In 14.4% of teachers, difficulties arose in determining the amount of material for presentation during distance learning. The remaining 21.1% of teachers gave some other reasons to argue their answers regarding the time required for preparation.



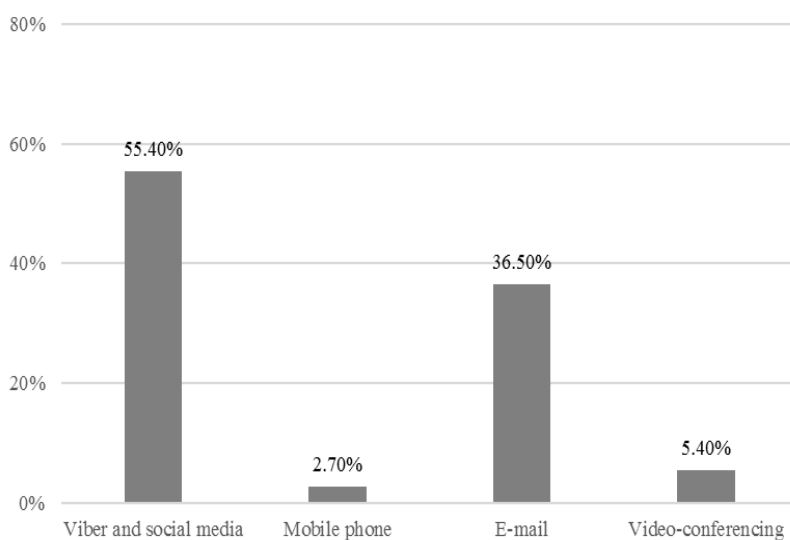
*Figure 3. Difficulties in developing teaching materials for distance learning*

These answers could be summarized as follows: teachers were preparing materials for distance learning for the first time so they needed

a lot of time, materials had to be detailed, and a special problem was the development of materials for students attending classes according to individualized educational plans (IEP-1 and IEP -2).

*Examining the way Teachers Communicated with Colleagues, Students and their Parents*

Cooperation between students during distance learning should not be overlooked. If the teacher only distributes certain materials, sends assignments to students and evaluates their answers in a longer period of time, and there is no possibility of interaction between students, online teaching loses quality, significance and purpose (Sorak, 2020). Therefore, one of the research tasks was to examine the ways in which teachers communicated with students, colleagues and their parents. The obtained answers are shown in Figure 4.



*Figure 4. Means of communication of chemistry teachers with students and their parents*

The obtained results show that more than half of the teachers communicated with students and their parents via Viber and social networks, followed by e-mail, video conferencing and telephone.

Young people spend a lot of time using social media as the primary means of communication and electronic socialization (Golder, Wilkinson, & Huberman, 2007), and during the pandemic there is an exponential growth of groups and exchange of experiences between them. Thanks to the Internet and social media, the unusual situation in which teachers

found themselves contributed to the creation of a “virtual community of chemistry teachers” (Dominici, 2020). Therefore, the next question in the questionnaire referred to the membership of the respondents in one of the groups on social networks that bring together chemistry teachers. Although as many as 74.3% of teachers were members of at least one of these groups, only 33.8% of teachers stated that they exchanged experiences and teaching materials with other members. Regardless of whether they were members of groups on social networks or not, the opinion of the majority of teachers (68.9%) is that the exchange of experiences and opinions helped them resolve doubts and the exchange of teaching materials.

#### *Examining Opinions of Teachers on Student Assessment during Distance Learning*

One of the important challenges of distance learning is how to implement the assessment process. Teachers make great efforts to find the most effective ways to assess knowledge of their students and suggest different steps to reduce the possibility of cheating during assessment (Lewis, 2020). The fourth research task was to examine opinions on how assessment was organized during distance learning. This task was realized through three questions. The first question referred to the activities that the teachers assigned, which they evaluated and graded. The largest number of teachers (32.6%) gave assignments to students in the form of homework in which students solved tasks (arithmetic, essay, etc.) and sent solutions to the teacher. Also, teachers used interactive tests (e.g. Google questionnaire and similar tests) when assessing students – these tests were used by 19.1% of respondents. A slightly smaller number of surveyed teachers (17.7%) applied the tests in written form (in Word format, etc.) which was filled in by students and sent to the teacher. Teachers used the group assignments and projects to a lesser extent (14% and 9.3%, respectively). Only 5.1% of the surveyed teachers applied oral examination through live meetings. A small number of teachers (2.3%) evaluated other forms of student activities, such as making PowerPoint presentations and other student presentations of learned content, performing experiments at home and didactic games.

Next, the opinion of the teachers on whether the assessment in the applied distance teaching was objective enough was examined (Figure 5). Only an extremely small number of surveyed teachers (2.7%) believe that assessment was objective, while the majority (79.7%) believe that it was not objective, because most students use the help of others (parents, friends, learning materials) in solving problems and tests. The remaining 17.6% were not sure to what extent the assessment was objective. The questions in the survey were designed in such a way that the teachers had the opportunity to append their answer, comment, write opinions and/or

suggestions. When it came to objectivity and the application of different assessment tools, one teacher said, “*What d\*\*n test! It’s pure copying, even teachers – my colleagues, call me to help their children.*”

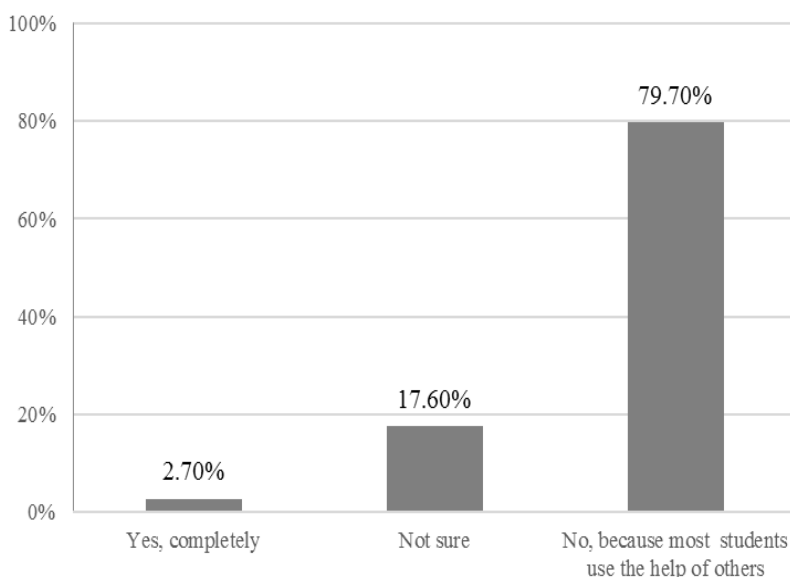


Figure 5 Teachers' opinion on the objectivity of online assessment

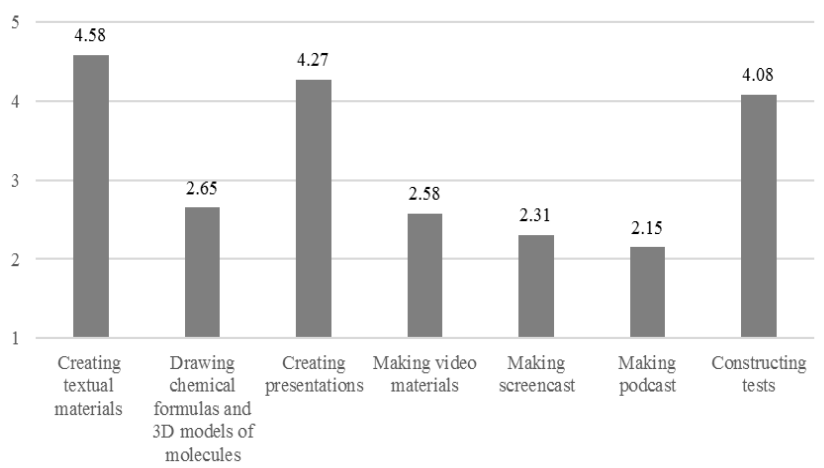
In the third question of this segment, teachers suggested ways to overcome the problem of assessment during distance learning. The largest number of teachers (22.4%) stated that it might be the creation of personalized tasks, different for each student. Almost the same number of teachers (13.1 and 12.2%) believe that the use of software to generate different tests for each student from the question database and the use of time-limited tests would also contribute to more efficient and objective assessment of students during distance learning. One study confirmed that combining time-limited tests obtained from a question bank with the use of adequate distance assessment software reduces the possibility of student manipulation (Lewis, 2020).

The surveyed teachers mentioned writing essays or longer answers to questions (9.6%), assigning problem tasks (6.4%) and writing projects/essays (3.5%) as possible solutions. Only 1.6% of teachers believe that oral examination using video technology could overcome the problems related to assessment.

*Examining Teachers' Opinions on their Teaching Competencies and Need for Professional Development*

Teacher competencies are essential for the integration of ICT in teaching. Teachers make decisions on the forms of ICT they use and the manner of their implementation in the teaching practice. There is evidence that teachers use ICT more to prepare for class than they do in class (Suárez-Rodríguez et al., 2018). Digital competencies are necessary for the implementation of distance learning in all stages, from the preparation of instructional materials, teaching itself, communication with students and parents, to assessment.

Based on 3 questions, this research examined how teachers perceive their own competencies for distance teaching and whether they have the need for professional development in the field of making materials for distance learning and the teaching process. These results are very important because previous experiences and competencies of teachers, in addition to the availability of digital tools, are very important for the quality of distance learning (Dominici, 2020). Teachers were asked to assess their skills in making different forms of teaching materials (on a scale of 1-5). The results showed that they are best skilled in making textual materials in MS Word, and making presentations and tests, while the self-assessments of teachers' skills to create other forms of teaching materials were uniform and low (Figure 6).



*Figure 6. Self-assessment of the teachers' competencies and skills in making teaching materials*

There is a clear connection between the selection and application of teaching materials that teachers used during distance learning and self-assessment of their skills to produce these materials. Respondents mostly

chose to make those teaching materials for the production of which they have more knowledge and skills. The connection is obvious in all teaching materials except for the application of educational movies and the skills for their production. It was noted that many teachers stated they had used educational video-clips but that their skill to make and edit them was inadequate. This result is justified taking into account the fact that most textbooks are accompanied by a CD with recorded experiments.

The next question examined whether chemistry teachers had the habit of using the same platforms and applications they used during distance learning (e.g. Google Classroom, Edmodo, Microsoft Teams, Socrative) in the period before schools were closed. Most teachers (86.5%) had never used any of the platforms before, but had to learn them for teaching purposes.

The need of teachers for professional development in terms of methodological training for distance learning (how to plan content, how to write teaching scenarios for the classes, how to assess students, how to work with students who follow IEPs, etc.) and in terms of training for using programs for the creation of teaching materials and platforms for conducting such teaching (Figure 7) is such that more than half of the teachers believe that they need additional training in all examined segments.

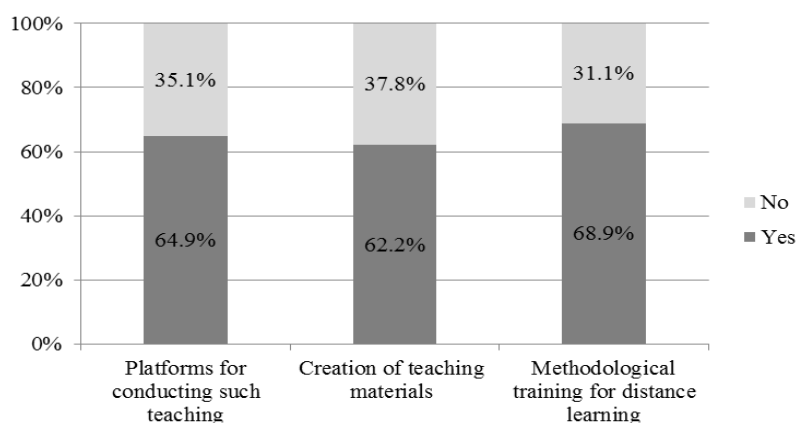


Figure 7. The need for professional development of teachers in different segments of distance learning process

#### *Examining Opinions on the Satisfaction of Teachers and Students with the Realized Distance Teaching*

At the end of the questionnaire, teachers were asked for their general attitude to distance learning. Obtained results (Figure 8) show that teachers are ambiguous on this matter. 29.7% of teachers have a generally positive attitude, while a slightly higher number of teachers (37.8%) has a

generally negative attitude. One third of teachers (32.4%) have not formed an attitude towards distance learning. Less than a third of teachers (27%) are of the opinion that students like this type of teaching, while 24.3% of them think that they do not like it. 36.5% of teachers think that students have neither positive nor negative opinions. As many as 12.2% of teachers stated that they did not know what their students think because they have not even asked them about their experiences and opinions.

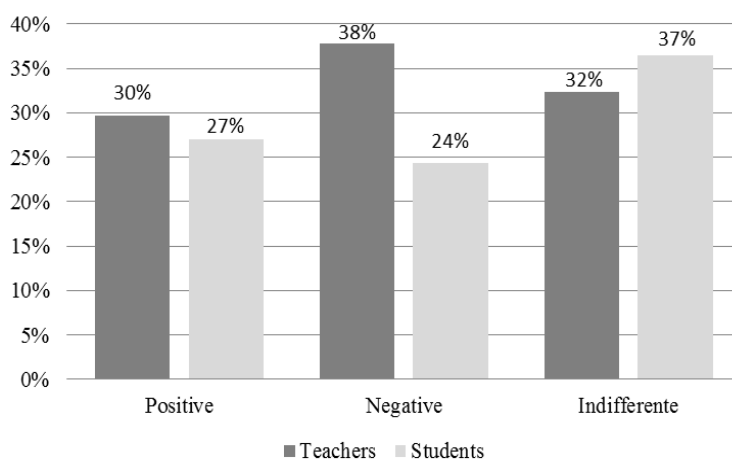


Figure 8. Attitudes of teachers and their students about distance learning

When asked about what the most difficult part for them was during distance learning, teachers answered that they had issues with not having contact with students (35.3%), with explaining abstract content without live contact with them (32.6%) and with having no feedback on the efficiency of their own work (24.5%).

### CONCLUSION

The aim of this paper was to examine the opinions of chemistry teachers about distance learning realized during the Covid-19 pandemic. In this way, information is provided on how chemistry teachers have implemented distance learning and knowledge assessment, what has been done successfully and what could be improved.

A third of teachers reported that during the school closure in the period from March 17 to June 15, 2020, their students followed the teaching content that was broadcasted on the channels of the Public Broadcasting Service of Serbia. In addition, the majority of teachers implemented online teaching using the Google classroom platform. Digital learning materials that teachers created were most often presentations, videos, and

online tests. Communication with students and parents was primarily via Viber and social networks.

Distance teaching of chemistry raised several questions. Most teachers had issues with the time available for the preparation and realization of distance learning compared to preparing and conducting regular classes. The difficulties that arose during the planning of the class were the consequence of their inexperience in making materials for distance teaching and the lack of interaction with students. As a big problem in distance teaching, chemistry teachers singled out the assessment process. Although they had different approaches to assessment and applied a wide range of activities, such as homework, student presentations, tests, questionnaires, etc., they agreed that assessment was not objective enough. They listed some of the suggestions so that the evaluation process could be improved, e.g. creating a question bank, limiting test time, or differentiating tasks for each student.

Chemistry teachers have clearly indicated the need for professional development in the field of digital teaching materials for distance learning, working with software and platforms for teaching, but also in the field of methodological training and preparation for such teaching. General attitude and satisfaction of chemistry teachers about the realized teaching was divided - an equal number of teachers were either very satisfied or dissatisfied. Their perception of student satisfaction is similar.

The significance of this research is manifold. The results of retrospective studies such as this can create hypotheses about the most efficient platforms and forms of assessment in chemistry and can be used to initiate innovations in teaching. Such results are crucial for educators to implement in their teaching process. The results provide relevant information to the Ministry of Education, Science and Technological Development and the Institute for Improvement of Education, for the evaluation of the teaching process, and based on the presented results that can strengthen support to schools and teachers in various segments (training, technical support, equipment purchase, etc.). Also, the results of this investigation are very important for further research in the field of chemical education because they provide a basis for further research not only in this field, but for education in general.

Finally, the results should be seen in the context of certain limitations of the presented research. The research was conducted on a convenient sample of chemistry teachers with whom a successful cooperation was achieved previously. In addition, self-assessment scales were used that may be influenced by current mood or wish of teachers to give a desirable response and thus convey a good impression of their abilities and competencies. These problems potentially limit the possibilities to generalize results. In future research, it would be desirable to observe the teaching process of chemistry during distance learning from the perception of students.



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## НАСТАВА ХЕМИЈЕ НА ДАЉИНУ ТОКОМ ПАНДЕМИЈЕ КОВИД-19 – ИЗАЗОВИ И РЕШЕЊА

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### Резиме

У Републици Србији је, као и у већини земаља широм света, настава током ванредног стања изазваног пандемијом ковид-19 реализована емитовањем наставних садржаја на каналима Јавног сервиса Србије. На овај начин је обезбеђен континуитет у образовању ученика. Предавања су снимана и емитовани су часови наставе за ученике основних и средњих школа. Настава на даљину је замишљена као комбиновање ТВ наставе, интеракције наставника и ученика кроз различите платформе и апликације и самостално учење ученика.

Реализација наставе хемије током пандемије ковид-19 представља јединствен изазов наставницима због природе самог предмета. Овај рад је осмишљен тако да прикаже како су наставници хемије реализовали наставу на даљину у периоду од 17. марта до 15. јуна 2020. године, са којим проблемима и изазовима су се срили, шта је успешно урађено и шта би се могло побољшати. У истраживању је учествовало 75 наставника хемије основних и средњих школа. Резултати су показали да је трећина наставника и ученика пратило наставне садржаје из хемије који су емитовани на каналима Јавног медијског сервиса Србије. Највише

наставника је реализовало наставу на даљину користећи Гугл учионицу и примењујући наставне материјале које су сами израђивали у форми презентација, видео-материјала и тестова, док је комуникација с ученицима и родитељима у највећој мери сведена на Вибер и друштвене мреже. Наставници хемије су имали потешкоће током планирања и припреме наставних материјала, али и током оцењивања, које по мишљењу већине наставника није било објективно. Према мишљењу наставника постоји неколико начина за превазилажење проблема с оцењивањем: израда персонализованих задатака, коришћење софтвера за генерисање различитих тестова за сваког ученика из базе задатака; коришћење тестова са ограниченим временом за израду, писање есеја/дужих одговора на питања, задавање проблемских задатака и израда пројеката/ радова. Генерални став и задовољство наставника хемије о реализованој настави је подељено – док је део наставника веома задовољан, други део је незадовољан. Наставници хемије су јасно указали на потребу за стручним усавршавањем у области израде материјала за потребе наставе на даљину, рада са софтверима и платформама за реализацију саме наставе али и у области методичке обуке и припреме за наставу на даљину.

Резултати истраживања пружају релевантне информације о платформама и облицима оцењивања у хемији, и могу се користити за покретање иновација у настави. Овакви резултати су од пресудног значаја за просветне раднике за имплементирање у свој наставни процес. Резултати пружају информације и Министарству просвете, науке и технолошког развоја као и Заводу за унапређивање васпитања и образовања, на основу којих могу да појачају подршку школама и наставницима у различитим сегментима (обуке, техничка подршке, куповине опреме, итд).