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RELIABILITY AND VALIDITY OF THE INSTRUMENT ASSESSING THE EFFECTIVENESS OF ONLINE AND REGULAR CLASSROOM LESSONS

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Keywords:
reliability;
validity;
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students;
teachers.

Abstract. In order to propose a new instrument for evaluating the efficiency of teaching process, this paper presents the recently designed tool called Online and Classroom Teaching Efficiency Scales – OCTES. It strives to examine reliability and validity of the OCTES scale on a sample of students (N1=100) and teachers (N2=100). The instrument used to evaluate the effectiveness of three aspects of teaching in two teaching scenarios—classroom teaching and online teaching— includes 3 scales related to cognitive, conative, and affective aspects of teaching. The results indicated that all scales have high reliability (over .80 Cronbach's alpha) on both the teacher subsample and the student subsample. The construct validity was verified by exploratory factor analysis. The results have confirmed that one-factor solutions are acceptable for all measured scales, with the explained variation ranging from 41.13% during the assessment of the affective component of classroom teaching, to 64% during the assessment of conative aspects of classroom teaching. It can be inferred that the final version of the 30-item scale showed good psychometric properties reflected in high reliability of all assessed aspects of teaching efficiency and solid validity seen through one-factor structure of all scales.

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Introduction

Since the modern age and the progress of technology have accelerated our lives in all possible aspects of it, as well as in educational technologies, which offer us different opportunities to communicate in education itself, among students, among teachers, and between students and teachers, and offer different opportunities for pedagogical practice (Taylor, 2001; Milojević et al., 2020).

Teaching is one of the most important activities that takes place in school. It is a very complex, planned, and organized process where students, through their own activity, guided by the skilful teacher, acquire knowledge, skills, and habits, and develop psychophysically. Teaching consists of two complementary processes, the first referring to the teaching process, for which teachers are predominantly responsible, and the second is the learning process, which mainly depends on students. Teaching and learning are two poles of a single process, which mostly depend on each other, and which are supported and improved by one another (Luteršek & Backović, 2014).

After the circumstances that arose as a result of the COVID-19 pandemic (starting in March 2020), it was necessary to adapt the existing education system to the new conditions and ensure a minimum education process at all levels. It was not possible to do that live in the classrooms, it was necessary to switch to different forms of distance learning, i.e., online teaching. Online teaching is a type of instruction that is not completely new. The development of information and communication technology at the end of the 20th century enabled the use of technologically supported systems and learning environments. The main goal and advantage of such systems is to facilitate all elements of instruction that are used in the traditional education process: transfer and sharing of knowledge, interaction and synchronous communication, practical application of knowledge, as well as tools to assess what has been learned (Arsenijević, 2021).

It is obvious that its use became inevitable due to the pandemic caused by the coronavirus. Online teaching can be defined as the use of multi-media and the Internet in order to improve the quality of learning, which provide access to resources and services and which enable communication and cooperation

at a distance (Ćukušić & Jadrić, 2012; Jakšić et al., 2021). Online teaching itself offers a number of advantages over the traditional teaching method, and some of them relate to flexibility in terms of time and place of transfer and reception of knowledge, reduction of the use of travel resources and other costs, as well as the possibility to participate in classes with any device (Rapanta et al., 2020). Regular classroom teaching is such a form of organization of lessons that usually takes place in classrooms (Castronova, 2002). This type of instruction has numerous advantages over online learning, and some of them are that the mere presence of teachers can motivate students, it affects emotional engagement, and results in controlled and regulated knowledge evaluation, as well as the ability to conduct experimental exercises (Arkorful & Abaidoo, 2014).

Meyer and Turner (2002) believe that motivation, cognition and emotion are three related aspects of human learning. Bear et al. (2003) emphasizes the motivational role of emotions in the learning process. Ford (Ford, 1992, in Meyer & Turner, 2020) believes that emotions are inseparable from motivation, while Lazarus (Lazarus, 1991, in Meyer & Turner, 2020) believes that emotions are a concept that includes cognition, therefore emotions are inseparably motivational, as emotions occur only when something is very important. According to Pekrun's theory (Pekrun, 2008, in Kolak & Majcen, 2011), students are mediated by numerous cognitive, motivational and regular mechanisms. The author Ranđelović (Ранђеловић, 2017) talks about three parameters of teaching efficiency: cognitive, conative, and affective.

The authors measured the efficiency of teaching in different ways, thus getting different results. According to Bloom (1976), the ultimate goal of effective teaching process was to identify the generic characteristics and dimensions of effective teaching, to measure teacher actions that affect student learning outcomes, and to establish the relative impact of contextual conditions that may affect teacher efficiency.

Some pedagogues highlight that the notions of efficiency and effectiveness are sometimes intertwined in the literature (Jovanović, 2017). The author Jovanović (2017) claims that the essential difference between these two concepts was pointed out by Peter Drucker (2006), who compared this distinction with the differences between managers and leaders: efficiency means doing things the right way, while effectiveness means doing the right things (Drucker, 2006, in Jovanović, 2017). So, the method, that is, the procedure is important for efficiency, while the result is important for effectiveness. The difference between these two notions mentioned in *Psihološki rečnik* (*Dictionary of Psychology*) is explained as follows: "the effect is the consequence of an action, and efficiency is the ratio between invested effort and outcome" (Krstić, 1988, p. 14). The authors Lockheed and Hanushek (1994) see the distinction between the above-mentioned concepts in the way that they see efficiency as a ratio between inputs and outputs and resources, and describe effectiveness in education as an aspect that has effects on student achievement.

Therefore, effectiveness does not necessarily imply efficiency, i.e., what is effective does not have to be efficient. Focusing on the concept of pedagogical effectiveness, the author Jovanović believes that pedagogical effectiveness actually refers to the final outcome of specific analyses that measure the quality of achievement of certain learning objectives (Jovanović, 2017, p. 79). In the explanation section, the above-mentioned author focused on the effectiveness of regular, classroom lessons. On the other hand, some authors, assessing aspects of the effectiveness of online teaching, talk about the importance of analysis and evaluation of the functionality of existing platforms for online instruction (Novaković, 2021).

In the psychological literature, the efficiency of instruction is mainly seen through the success of the teaching process. The success of the teaching process is a multidimensional construct, so the assessment of the effectiveness of the teaching process is complex. The author Petrović-Bjekić (2000) measures the success of teachers and teaching through: self-assessment of overall performance, self-assessment of teacher role performance, student assessment of overall performance, student assessment of teacher performance, student motivation for the subject as an indicator of teacher influence on learning and average student achievement (Petrović-Bjekić, 2000, p. 499). It is important to highlight that this paper promotes the idea that teaching efficiency should be seen both from the point of view of teachers and from the point of view of students. Also, as for the efficiency of the teaching process and teachers, the author repeatedly emphasizes the importance of understanding the cognitive outcomes of the education process (acquired knowledge), but also the conative aspects viewed through student motivation.

In his research called *Efficiency and Psychological Foundation of Teaching through Insight Problem Solving*, the author Ranđelović (Ранђеловић, 2017) measured the efficiency of teaching with a number of instruments. On the sample of 102 students of the fourth grade of primary school, the paper empirically compares the efficiency of traditional teaching (as a representation of traditional teaching system) and problem-based learning (as a form of modern teaching system). The teaching system is defined as a "designed, arranged, rational, and economical structure of teaching" (Poljak, 1977, p. 6). In this definition of the teaching system, the emphasis is on structure of the teaching process, and in essence it refers to the organization of learning during the teaching process. Ranđelović measured the efficiency of teaching indirectly through three parameters: the amount of learned material (evaluation of the cognitive component of the teaching process), emotional experience of the lesson (a measure of the affective component), and the level of motivation to learn (assessment of the conative component of teaching) (Ранђеловић, 2017, p. 172).

As for the specific instruments, the author used the following: The knowledge test he used to measure the amount of material learned; scale for assessing the level of motivation to learn in class, in order to measure the conative

component of teaching; Current Emotional Status Assessment Scale and Semantic Differential (6 notions were assessed for each unit taught, and the perception of the meaning of each notion was assessed through the dimensions of activity, potency, and evaluation) as a measure of the emotional component of teaching. All instruments used in the study showed good psychometric characteristics, the reliability of the instrument ranged from 0.75 to 0.93. In this research, the author Ranđelović (Ранђеловић, 2017) confirmed the partially higher efficiency of problem-based compared to traditional teaching, primarily in the cognitive aspect. However, it should be noted that when it comes to motivational and emotional aspects, as the author himself reports, the instruments used failed to identify finer differences in motivation and emotional experience of teaching when organized either in a problem-based or traditional way because the duration of the experiment was too short (two learning weeks) for the mentioned differences to be manifested (Ранђеловић, 2017, p. 186).

Rowbotham & Schmitz (2013), relying on Bandura's social learning theory, suggest that efficiency continue to be measured through the student self-efficacy scale, while De Smul et al. (2018) propose a scale of teacher self-efficacy as a good measure for assessing the effectiveness of teaching.

The research, which measures self-efficacy in online teaching, describes the process of measuring this aspect of learning. For the purposes of this research, data were collected with the Socio-Demographic Questionnaire, as well as with a scale consisting of 22 items that measure the self-efficacy of learning in the online environment. Items ranged from 1 to 5, where 1 is completely disagree and 5 completely agree. Also, in order to speed up the process of research and data collection, everything was done with an online questionnaire. The research sample at the end of the fourth week was a total of 2,230 students. The scale which measured efficiency consisted of three factors and 22 items. The highlighted factors related to 1) the specifics of learning in an online environment, with a total of 10 items; 2) time management with 5 items; and 3) the use of technology with 7 items. The reliability of the whole instrument was .890 (Yavuzalp & Bahcivan, 2019).

A review of the literature on the effectiveness of teaching in our region (Ранђеловић, 2017), gives the impression that there are not enough instruments designed to measure various aspects of teaching effectiveness. Therefore, the focus of researchers in this paper is to try to design and verify the psychometric properties (reliability and validity) of the instrument designed to assess the cognitive, conative, and affective components of teaching, both those that take place live in classrooms and in distance learning through existing online learning platforms.

Of course, whenever a new psychological measuring instrument is designed, it is necessary to precisely determine its psychometric properties. Although psychometric properties include a large number of characteristics: objectivity, reliability, discrimination, validity, calibration, economy (Momirović et al., 1999).

However, the author Kostić (2007) points out that the reliability and validity of the instrument are more important (p. 192). Reliability of the test, in the broadest sense, refers to the accuracy of test measurements (Kostić, 2007, p. 193). It is primarily expressed as the repeatability of test scores for the same participants on the same test in repeated measurements. The reliability index shows us to what extent the differences in the participants' scores on the same test are the result of actual differences in the property measured by the test, and to what extent they are the result of random (uncontrolled, parasitic) factors. Depending on which source of measurement inaccuracy we are interested in, different procedures for calculating reliability measures are used. In practice, four procedures are most often used: a) test-retest method; b) parallel-forms method; c) split-half reliability method; d) Kuder-Richardson formula (measuring reliability for a test with binary variables) (Kostić, 2007, p. 195). The latter procedure is the most common in checking the psychometric properties of newly formed instruments, and the Cronbach's alpha coefficient is taken as the most commonly used measure. Validity is one of the basic metric characteristics of measuring instruments, which shows whether it, roughly speaking, measures what it should measure (and not something else), and to what extent (Kostić, 2007). Different types of validity are mentioned in the psychometric literature: diagnostic, prognostic, content, synthetic, appearance validity, and construct validity. When constructing new instruments, the measure called construct validity is most often used and it is checked by factor analysis (Kostić, 2007, p. 213).

Taking into account all the above-mentioned issues, the researchers started writing this paper with the aim of designing an instrument that will assess the effectiveness of lessons, which both high school and university students would use to evaluate various aspects of the effectiveness of online and regular lessons. Therefore, the main research question is whether the newly designed instrument has satisfactory psychometric properties and whether it is appropriate for assessing the effectiveness of online and regular lessons among teachers and high school students.

Method

Research Objective. The general goal of this research is to verify certain psychometric properties (reliability and validity) of the OCTES scales (Online and Classroom Teaching Efficiency Scales). Reliability was checked with the internal-consistency method, while the main measure of the validity of the scales was the factor structure, therefore, we examined construct validity.

Sample. The sample consisted of 100 (N1=100) 4th grade students from three high schools in Kosovska Mitrovica (Medical School, Grammar School, and Mihajlo Petrović Alas Technical School), as well as their teachers (N2=100).

An equal number of male and female participants were selected in each school. In the teacher subsample, 66% were female participants and 34% male; 43 teachers from the Medical School, 39 teachers from the Grammar School, 18 teachers from the Technical School. The average age of teachers was 38.78 years. This structure of both samples (students and teachers) was conditioned by the structure of the students/teacher population in these three schools.

Procedure. The research was conducted in May of the 2020/2021 school year. The research was conducted with the consent of both schools as well as with the consent of each student participating in the research. During one school lesson (30 minutes, then shortened due to the epidemiological measures), students filled in the scales to assess the effectiveness of online and regular classes.[5] As for the teachers, they were explained in detail the entire research procedure, and then asked to fill in the scale. Students completed the OCTES-u, a student version, and teachers completed a parallel form of the scale: OCTES-n.

Description of Instruments. OCTES (Online and Classroom Teaching Efficiency Scales) consisted of a total of 33 items which students answered on a scale from 1 to 5. The instrument consisted of three scales that are focused on three dimensions: cognitive, conative, and affective. The complete instrument is constructed in two parallel forms: OCTES-u, student version and OCTES-n teacher version. Thus, the assessment of the effectiveness of teaching is viewed from the perspective of students and from the perspective of teachers.

• Scale for assessing the cognitive aspect of teaching efficiency – consists of 11 items related to the cognitive aspect of teaching (thinking, memory, skills, abilities). The students answered on a five-point scale from 1 to 5, to what extent they agree with a certain item (1-absolutely incorrect: 5-absolutely correct). Items related to the cognitive aspect are, for example: *I feel that during classes my attention is focused primarily on work, I easily remember the material while the teacher teaches, During classes we acquire important skills and abilities...* All 11 items were related to online and classroom lessons. A parallel version of the scale was also constructed for teachers where the items are on the cognitive level, e.g. *During classes, the students' attention is focused primarily on work, memorized material lasts longer, and students acquire important skills and abilities during the lessons.*

• Scale for assessing the conative aspect of teaching efficiency – It consists of 8 items related to the conative aspect of teaching (motivation, desire). The initial version consisted of 11 items, but in the pilot study of scale verification (N = 70) three items were rejected after item analysis and preliminary factor structure verification as there was low saturation of the factor that stood out, and reliability of the entire scale grew after omitting these two items. The students

[5] Students included in our sample had combined lessons, meaning that one week they attended live classes and the next week online lessons.

answered questions using a five-point scale from 1 to 5 to state to what extent they agree with a certain item (1-absolutely incorrect: 5-absolutely correct). The items related to the conative aspect are, for example: *I am very motivated to learn during lessons, I have a great desire to learn during lessons, My interest in learning is great during lessons...).* All 11 items were related to online and regular classes. A parallel version of the scale is also constructed for teachers where the items relate to the conative level, for example: *Students are very motivated to work during classes, Students have a great desire to learn during classes, Students are very interested in learning during classes.*

• Scale for assessing the affective aspect of teaching efficiency – it consists of 11 items related to the affective part of teaching (emotions). Students answered the questions on a five-point scale from 1 to 5 to what extent they agree with a certain item (1-absolutely incorrect: 5-absolutely correct). Items related to the affective aspect are, for example: *I feel comfortable during classes ... My day is more complete when I have lessons..., I am much happier when I'm in lessons ...).* All 11 items were related to online and classroom lessons. A parallel version of the scale is also constructed for teachers with items relating to the affective level, for example: *Students feel comfortable during classes, Students have a more complete day when they have lessons..., Students are much happier when they have lessons).*

The entire instrument is designed to assess different aspects of lesson efficiency, and all the scales it contains are independent and can be used together or separately.

Data Analysis Techniques. Cronbach's alpha coefficient was used to verify the internal reliability of all scales of the tested instrument, while the exploratory factor analysis, the principal component analysis, was used to test the factor analysis.

Since the majority of authors (Simić, 2015; Ранђеловић, 2017; Ранђеловић & Михајловић, 2021), who emphasized the importance of looking at different aspects of lesson effectiveness (cognitive, conative, affective) in their works looked at each of those aspects separately, so statistical analysis should be performed for each of the scales separately.

Results

The overview of results will first present the main descriptive indicators and information related to the reliability of the scale. Firstly, the described parameters will be shown, as well as the reliability of all dimensions in online and classroom lessons. The reliability of the scale for both students and teachers will be shown.

The dimensions of teaching will be presented first, as well as the reliability of all dimensions.

Table 1. Reliability of all instrument scales

Evaluated aspects of teaching	Individual scales	Sample					
		Students			Teachers		
		n	N	α	n	N	α
Assessment of cognitive aspects of teaching	Scale for assessing the cognitive aspects of online teaching	100	11	0.86	100	11	0.93
	Scale for assessing the cognitive aspects of classroom lessons	100	11	0.82	100	11	0.82
Assessment of conative aspects of teaching	Scale for assessing the conative aspects of online teaching	100	8	0.919	100	8	0.90
	Scale for assessing the conative aspects of online teaching	100	8	0.92	100	8	0.90
Assessment of affective aspects of teaching	Scale for assessing affective aspects of online teaching	100	11	0.88	100	11	0.81
	Scale for assessing affective aspects of online teaching	100	11	0.84	100	11	0.84

Notes: n – number of participants, N – number of items, α – Cronbach's alpha coefficient

Table 1 clearly shows that the reliability of all scales on all three aspects is high and that this applies to both the version used for students and the version used for teachers. In the subsample of students, the highest reliability is the scale of assessment of conative aspects in online teaching (α = .922), and the lowest in the scale of assessment of cognitive aspects of classroom lessons (α = .82). When it comes to teachers, the highest reliability was shown by the scale of assessment of cognitive aspects of online teaching (α = .93), and the lowest by the scale of assessment of affective aspects of online teaching.

Item analysis within the method of reliability verification through internal consistency showed the following results:

A) Item analysis of the items in the scale for the assessment of cognitive aspects of teaching. When assessing the cognitive aspects of online teaching, it was shown that there is a significant positive correlation between the item and total score for all items, where in the case of as many as 9 items the correlation was over .45 in the student subsample, and over .73 in the teacher subsample. The analysis also showed that excluding any of the examined items from this subscale would not improve the reliability of the entire scale. Corresponding results were also seen during the assessment of classroom lessons.

B) Item analysis of the items in the scale for the assessment of conative aspects of teaching. Since two items were already excluded from the initial version of this subscale (which had 11 items) after the first pilot check of the scale, 8 items were included in the subsequent analysis and proved to be consistent. The correlation between items and the total score in the case of this scale during the assessment of online classes was significant and high in all 8 items and ranged

from .56 (for item 6) to .88 (for item 2) in the sample of students, and from .36 (item 8) to .80 (item 2) in the teacher sample. The analysis also confirmed that removing any single item would not increase the reliability of the entire scale. Corresponding results were also seen during the analysis of classroom lessons.

C) Item analysis of the items in the scale for the assessment of affective aspects of teaching. All 11 items showed that they had high levels of correlation with the overall score both in the assessment of online teaching and in the assessment of classroom lessons. The item-total correlation ranged from .57 for item 10 to .73 for item 7 on the student subsample, and .53 on item 8 to .78 on item 4 on the teacher subsample. Excluding any of the items would not improve the reliability of the entire scale.

Table 2. Overview of certain dimensions (descriptive parameters) in students' and teachers' assessment of the effectiveness of teaching

	Students				Teachers			
Assessment dimensions	Min	Max	M	SD	Min	Max	M	SD
PKKON	1.18	5.00	2.98	.88	1.00	4.91	2.85	.98
PKKRN	1.27	5.00	3.96	.83	2.82	5.00	4.39	.44
PMKON	1.00	5.00	2.70	1.04	1.00	4.63	2.80	.94
PMKRN	1.13	5.00	3.76	.84	1.88	5.00	4.27	.61
PAKON	1.00	5.00	2.99	.92	1.00	6.00	3.03	1.01
PAKRN	1.45	4.73	3.74	.69	1.73	5.00	4.14	.74

Note: PKKON-assessment of the cognitive component of online teaching; PKKRN-assessment of the cognitive component of classroom lessons; PMKON-assessment of the conative (motivational) component of online teaching; PMKRN-assessment of the conative (motivational) component of classroom lessons; PAKON-assessment of the affective component of online teaching; PAKRN-assessment of the affective component of classroom lessons

Table 2 shows mean values, standard deviation and range at the level of items for the participants' answers on all scales for measuring the efficiency of teaching. It can be noticed that in the case of both students and teachers, all components of the assessment of the effectiveness of teaching (cognitive, conative and affective) are more pronounced in the case of classroom lessons compared to online lessons. This was also verified with t-test for repeated measurements. The results confirmed that:

- there is a significant difference in the assessment of the cognitive aspect of teaching depending on whether it is in online format or in classroom format both in student subsample ($t(99) = -8.724$, $p < .001$), and in teacher subsample ($t(99) = -14.288$, $p < .001$).

- there is a significant difference in the assessment of the affective aspect of teaching depending on whether it is in online format or in classroom format both in student subsample ($t(99) = -6.572$, $p < .001$), and in teacher subsample ($t(99) = -7.532$, $p < .001$).

Construct validity of the scale was checked using exploratory factor analysis. The principal component analysis was used. Varimax was used for the rotation method. The structure of all three subscales was partially checked, since they measure separate aspects of teaching (cognitive, conative, and affective).

Since the factor structure of the scale was examined, in which there were two parallel forms (for students and teachers), for the sake of brevity and conciseness of the overview, the results of factor analysis for the student sample will be presented here. Entirely corresponding data (with small deviations of values, which are not statistically significant) were obtained on the sample of teachers, noting that the same factor structure of all subscales was obtained on the sample of teachers as on the sample of students.

Tables 3, 4 and 5 show the results of factor analysis assessing the cognitive aspect of teaching.

Table 3. Characteristic values (*Eigenvalues*) and percentages of explained variances for factors extracted based on the principal component analysis (students' cognitive component)

	Total Variance Explained					
	Assessment of online lessons			Assessment of classroom lessons		
Component	Total	% of explained variance	Cumulative %	Total	% of explained variance	Cumulative %
1	5.00	46.276	46.276	5.644	51.311	51.311
2	1.262	11.476	57.752	1.114	10.124	61.435
3	.899	8.173	65.925	.917	8.338	69.773
4	.841	7.647	73.572	.787	7.156	76.929
5	.732	6.651	80.222	.675	6.141	83.069
6	.564	5.126	85.349	.535	4.864	87.934
7	.436	3.968	89.316	.420	3.822	91.755
8	.393	3.575	92.892	.300	2.728	94.483
9	.351	3.189	96.081	.244	2.219	96.702
10	.276	2.512	98.593	.224	2.038	98.740
11	.155	1.407	100.000	.139	1.260	100.000

Table 3 shows that two factors with characteristic values (*Eigenvalues*) over 1 were singled out, and the percentage of explained variance by two-factor solution was 57.75% when it comes to assessment of online lessons, and 61.43% when it comes to assessment of classroom lessons. The first isolated factor explains 46.27% of the variance for online lessons, and 51.3% in the assessment of classroom lessons.

Table 4 shows the results of the parallel analysis, in order to more precisely determine the factor structure of this segment of the instrument.

Table 4. Comparison of characteristic values (*Eigenvalues*) obtained in PCA and threshold values obtained by parallel analysis

Initial component number	Assessment of online lessons			Assessment of classroom lessons		
	Actual characteristic value from PCA	Value obtained by parallel analysis	Decision	Actual characteristic value from PCA	Value obtained by parallel analysis	Decision
1	5.090	3-0392	Accept	5.644	3.0392	Accept
2	1.262	1.5683	Reject	1.114	1.5683	Reject
3	.899	1.3863	Reject	.917	1.3863	Reject
4	.841	1.2771	Reject	.787	1.2771	Reject

PCA – Principal Component Analysis

The decisions in Table 4 show that the results for one factor were acceptable, while the others were rejected.

Table 5. Structure matrix (students' cognitive component)

Item	Assessment of online lessons		Assessment of classroom lessons	
	Components		Components	
	1	2	1	2
1. I feel that during classes, my attention is focused primarily on learning.	.644		.727	
2. I easily memorize the material while the teacher teaches.	.785		.872	
3. I understand the material well when the teacher teaches.	.832		.892	
4. Memorized material lasts longer.	.727		.769	
5. We acquire important skills and abilities during the lessons.	.771		.800	
6. I find it fine to ask a question during class and clarify what I find confusing.	.521	.433	.598	
7. I understand the practical use of what we learned in class.	.794		.743	
8. In class, I think more about other topics not related to the material taught.		.689		.901
9. It is not a problem to connect the current material with what we have previously learned.	.752		.764	
10. The exchange of opinions among students in class is intensive.	.593	.408	.563	
11. Teacher-student interaction is very productive.	.644		.719	

Extraction Method: Principal Component Analysis. a. 2 components extracted.

Although Table 3 shows that two factors with a characteristic value (*Eigenvalue*) over 1 were extracted, based on the method of parallel analysis given in Table 4, where it was shown that only one factor should be singled out, as well as the fact that only three items related to online classes and one item related to classroom lessons (Table 5) have a saturation factor over 0.3, we opted for the one-factor solution of this scale.

Tables 6 and 7 show the results of factor analysis assessing the conative aspect of teaching.[6]

Table 6. Characteristic values (*Eigenvalues*) and percentages of explained variances for factors extracted based on the principal component analysis (students' conative component)

Component	Total Variance Explained					
	Assessment of online lessons			Assessment of classroom lessons		
	Total	% of explained variance	Cumulative %	Total	% of explained variance	Cumulative %
1	5.160	65.506	65.506	4.559	56.990	56.990
2	.754	9.425	73.932	.930	11.624	58.614
3	.635	7.934	81.866	.706	8.825	77.439
4	.467	5.838	87.704	.668	8.345	85.784
5	.347	4.332	92.036	.440	5.497	91.281
6	.299	3.741	95.777	.302	3.774	95.055
7	.217	2.716	98.493	.209	2.612	97.667
8	.121	1.507	100.000	.187	2.333	100.000

Table 7. Structure matrix (students' conative component)

Item	Assessment of online lessons		Assessment of classroom lessons	
	Components		Components	
	1	2	1	2
1. I am very motivated to learn during classes.	.850		0.78	
2. During classes, my desire to learn is great.	.924		.875	
3. During classes, my interest in learning is great.	.866		.854	
4. When I'm in class, I wish to find out more about the topic we are discussing.	.823		.811	
5. During classes, increased motivation affects efficiency in learning.	.838		.	

[6] In the initial version of the analysis, the factor structure of the 11-item scale was verified, but since three items proved to act as negative saturation of the component they relate to, therefore the results of item analysis related to the reliability of this instrument suggested that they should be excluded from the final version, thus, the conative component remained with 8 items.

6. Cooperation among students is better during classes.	.739		.766	
9. During classes, my desire for a better grade is much higher.	.622		.617	
11. I cannot wait for the class to begin.	.722		.444	

Extraction Method: Principal Component Analysis. a. 2 components extracted.

Table 6 clearly shows that only one factor with an eigenvalue over 1 is singled out, so it is clear that this subscale measures a single factor. There was no need for subsequent parallel analysis. Table 7 shows the data related to the saturation of the extracted factor with the basic items.

Tables 8, 9, and 10 show the results of the factor analysis assessing the affective aspect of teaching.

Table 8. Characteristic values (*Eigenvalues*) and percentages of explained variances for factors extracted based on the principal component analysis (students' affective component)

Component	Total Variance Explained					
	Assessment of online lessons			Assessment of classroom lessons		
	Total	% of explained variance	Cumulative %	Total	% of explained variance	Cumulative %
1	5.424	49.313	49.313	4.525	41.137	21.137
2	1.089	9.898	59.210	1.398	12.711	53.849
3	.869	7.896	67.106	.927	8.424	62.272
4	.848	7.713	79.819	.848	7.712	69.984
5	.578	5.258	80.077	.688	6.256	76.240
6	.546	4.960	85.037	.644	5.842	82.092
7	.428	3.894	88.931	.566	5.146	87.238
8	.396	3.598	92.529	.491	4.462	91.700
9	.361	3.283	95.812	.355	3.225	94.925
10	.265	2.408	98.220	.304	2.768	97.693
11	.196	1.780	100.000	.254	2.307	100.00

In regards to the assessment of the affective component of teaching, the scale with 11 items showed that two factors have a latent root over 1 (see Table 8).

Table 9. Structure matrix (students' affective component)

Item	Assessment of online lessons		Assessment of classroom lessons	
	Components		Components	
	1	2	1	2
1. I am very motivated to learn during classes.	.795		.765	
2. During classes, my desire to learn is great.	.789		.763	
3. During classes, my interest in learning is great.	.766		.742	

4. When I'm in class, I wish to find out more about the topic we are discussing.	.761		.727	
5. During classes, increased motivation affects efficiency in learning.	.759		.652	
6. Cooperation among students is better during classes	.730		.644	.431
7. I am not inspired by...	.728		.641	
8. We are usually bored in class...	.703		.619	.493
9. During classes, my desire for a better grade is much higher.	.647		.546	
10. During classes, my motivation is significantly lower, because I do not want to attend classes.	.645		.527	-.525
11. I cannot wait for the class to begin...		.810		.706

Extraction Method: Principal Component Analysis. a. 2 components extracted.

Regarding the structure matrix (Table 9), we can see that the second extracted factor in the assessment of online teaching is saturated with only two items, so it is clear that it is not metrically justified to keep the solution with two factors.

Table 10. Comparison between characteristic values (*Eigenvalues*) obtained in PCA and threshold values obtained by parallel analysis

Initial component number	Assessment of online lessons			Assessment of classroom lessons		
	Actual characteristic value from PCA	Value obtained by parallel analysis	Decision	Actual characteristic value from PCA	Value obtained by parallel analysis	Decision
1	5.424	3.0392	Accept	4.525	3.0392	Accept
2	1.089	1.5683	Reject	1.398	1.5683	Reject
3	.869	1.3863	Reject	.927	1.3863	Reject
4	.848	1.2771	Reject	.848	1.2771	Reject

PCA – Principal Component Analysis

Based on the values shown in Table 10, after the parallel analysis, we can conclude that only one factor should be extracted, i.e., this is a one-factor scale.

From the aspect of ecosensitive variables, only gender was considered in this study. The difference in assessments of different aspects of teaching between male and female participants was examined.

When it comes to students, there were no statistically significant differences in assessments of all three aspects of teaching (cognitive, conative, and affective) both in relation to regular classroom and in online lessons, between male and female participants. Regarding teachers, the differences proved to be significant in assessing the cognitive component of regular classroom lessons ($t(98) = -3{,}661$, $p < 0.01$), the conative component of online lessons ($t(98) = -2{,}070$, $p < 0.05$), and affective components of regular classroom lessons ($t(98) = -2.434$, $p < 0.05$) In all three cases, female participants gave higher scores when assessing teaching efficiency than male participants.

Discussion

The main objective of this study was to examine the reliability and validity of the instrument for measuring the effectiveness of teaching, both online and classroom. The scale that is part of this instrument applies to both student assessment and teacher assessment. The scale was designed in two parallel versions—a version for high school students and a version for teachers. The obtained data related to reliability, both for individual dimensions in students and for dimensions in teachers (expressed through the Cronbach's alpha coefficient) indicate that it is a stable instrument (all the three scales) with high psychometric performance. The results showing that the reliability for both students and teachers is generally over 0.80 indicate that the instrument is extremely reliable.

Based on the item analysis, we can see that most items exhibit high correlation with the overall score on individual dimensions. All these tables indicate the stability of the instrument as a whole, as well as individual parts of it.

The validity of all the scales included within the instrument was checked with exploratory factor analysis of all assessment dimensions for both types of lessons—classroom and online. The principal component analysis was used (Kostić, 2007, p. 216). The structure of all three scales was partially tested, since they measure separate aspects of teaching (cognitive, conative, and affective). When it comes to assessing the cognitive aspect of teaching, although the preliminary analysis for each dimension singled out another factor with an intrinsic value over 1, subsequent parallel analysis and analysis of the structure matrix (Table 5) showed the justification of a single factor solution. Item 3 (*I easily remember the material while the teacher teaches*) and Item 4 (I *understand the material well when the teacher teaches*), mostly saturate the 1st isolated factor, both in assessing classroom lessons and in assessing the effectiveness of online lessons. Based on the content of the mentioned items (on memorizing and understanding the material in class), it is clear that these are precisely cognitive elements, and not some other aspects of the learning process. In regards to the conative aspect, in the initial version of the analysis, the factor structure of the 11-item scale was checked, but since three items showed negative saturation of the component they related to, and the results of the item analysis related to the reliability of this scale suggested that they should be excluded from the final form, the conative component remained with 8 items, while the other two dimensions will retain 11 items each. Since only one factor with an intrinsic value over 1 was singled out in the analysis (Table 6), there was no dilemma about choosing the number of factors.

When analysing the structure matrix, the two items that saturate the selected factor with the greatest intensity were: item 2 (*I have a great desire to learn during classes*) and item 3 (*My interest in learning is great during lessons*), and

based on their content, it is clear they refer to motivational aspects. As far as the affective component is concerned, the results were similar to the cognitive aspect, although the PCA at first extracted two factors with a characteristic value (*Eigenvalues*) over 1 were singled out first (using the Principal Component Analysis), and a one-factor solution was accepted by subsequent parallel analysis. In the structure matrix, we singled out item 1 (*I feel comfortable during classes*) and item 2 (*My day is more complete when I have lessons…*), as the ones that mostly saturate the selected factor, so the content of the mentioned items shows that these are emotional elements.

When it comes to average values (obtained on the basis of mean values of items) on individual scales (for the cognitive, conative and affective component of teaching efficiency), it was shown that both students and teachers valued regular classroom lessons more than online lessons. As an explanation of such findings, we can suggest the view expressed by some authors, that there is still insufficient readiness to use information technology in the education process, primarily by teachers (Nikolić & Milojević, 2020, in Miržić-Namet & Surdučki, 2020). Of course, it should be kept in mind that there are still a small number of empirical papers that focused on the efficiency of online instruction and on the comparison between the efficiency online lessons and regular classroom lessons.

The lack of statistically significant differences in the assessments of cognitive, conative, and affective aspects of teaching between male and female students, suggests that it is not necessary to use separate standards for male and female participants when it comes to this instrument. In the case of teachers, the partial differences obtained between certain components of classroom lessons assessment (cognitive and affective) and one component of online lessons assessment (conative) may indicate the need for additional testing of the instrument on a larger sample of teachers to have more reliable results.

All of the above-mentioned results clearly speak in favour of the high reliability of the scale and the satisfactory validity shown by the validity construct. Of course, the results of the above-mentioned analyses should be taken with caution, given the size and type of sample (non-random sample, 100 students, 100 teachers), the number and type of schools where it was used, and the fact that this is only the first psychometric test of a new instrument designed with the aim of measuring the effectiveness of regular classroom and online lessons. However, based on these results and analyses so far, we believe that the scale has proved suitable for use in a sample of high school students and their teachers, which of course should be supported by additional empirical tests and analyses of practitioners.

Although the organization of classroom and online lessons differs in many ways, and it is expected that the output parameters (in the form of learning objectives) will be qualitatively different in some aspects, the idea of creating an instrument that would measure the effectiveness of these two types of teaching relies on the assumption of a relatively balanced quantitative evaluations of various aspects of teaching efficiency. By obtaining certain values on the

parameters of cognitive, conative, and affective components of efficiency assessment, teachers will be able to make a preliminary assessment of the immediate outcomes of the teaching process, and based on this data will be able to plan possible improvements of certain aspects of the teaching process.

Conclusion

Given the relatively small scope of the instrument currently used by students and teachers to assess the efficiency of teaching, the attempt to design a new instrument is worthy of research attention.

The instrument has shown solid psychometric properties, which are reflected in the high reliability of all assessed aspects of teaching efficiency (cognitive, conative, and affective), as well as solid validity shown by the factor structure. According to the analysed results, all three scales can be independently used to assess different aspects of efficiency, both by teachers and students. Of course, it should be noted that the instrument cannot, and this was not the intention of the designer, to give an objective picture of the efficiency of the teaching process, which requires a systematic approach, synthesis, and external and internal evaluations, but its role is rather to analyse the opinions and assessment of the main aspects of teaching by various participants in the education process.

In any case, this instrument can be a useful tool if used in studies in the field of psychology of learning, especially related to the teaching efficiency assessment. A special benefit of the designed OCTES instrument lies in the fact that cognitive and conative (motivational) and affective (emotional) aspects of teaching efficiency are observed both from the students' point of view and from the teachers' point of view, which could not be done with previously designed instruments that measured the efficiency of teaching.

Moreover, this tool can be useful for teachers-practitioners who could use it, especially in phases of formative assessment of global achievement of learning objectives, as well as to compare current learning outcomes for the lessons organized in classrooms and those organized online.

In addition to the already mentioned limitations related to the research sample, it is important to mention that the evaluation of the instrument by practitioners-teachers, professional associates and other direct participants in the teaching process in primary and high schools is missing. Besides the additional assessment of the practical validity of the instrument, it would be useful for some future studies to examine some of the correlates of teaching efficiency (such as motivation, self-assessment of one's own success, classroom climate, learning habits, etc.).

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Поузданост и ваљаност инструмента за процену ефикасности онлајн и редовне наставе

Резиме

Полазећи од чињенице да је у Републици Србији мали број стандардизованих инструмента за мерење ефикасности наставе, у раду је презентована новоконструисана Скала процене ефикасности онлајн и редовне наставе – СПЕОРН. Циљ је био испитати поузданост и валидност скале СПЕОРН на узорку ученика (H1=100) и наставника (H2=100). Скала се састоји од три субскале које се

односе на когнитивни, конативни и афективни аспект наставе. Испитаници на скали процењују ефикасност три аспекта наставе у две наставне ситуације: настава уживо (редовна настава у учионицама) и онлајн настава. Формулисане су паралелне форме скале: за наставнике и за ученике. Резултати показују да све скале имају високу поузданост (преко .80 Кронбах алфа) и на подузорку наставника и на подузорку ученика. Већина ајтема показује високу корелацију са укупним скором на свим мереним аспектима наставне ефикасности. Ученици су на свим скалама процене наставне ефикасности постизали више скорове када су процењивали редовну наставу у односу на процену онлајн наставе. Проверавана је конструкт ваљаност експлоративном факторском анализом. Резултати су потврдили да су за све мерене скале прихватљива једнофакторска решења, при чему је проценат објашњене варијансе варирао од 41,13% код процене афективне компоненте редовне наставе до 64% код процене конативних аспеката редовне наставе. Закључак је да је коначна верзија скале са 30 ајтема показала добре психометријске карактеристике, које се огледају кроз високу поузданост свих процењиваних аспеката ефикасности наставе (когнитивна, конативна и афективна), као и солидне валидности сагледане кроз једнофакторску структуру свих скала. Све три скале се независно могу примењивати за процену различитих аспеката ефикасности и од стране наставника и од стране ученика.

Кључне речи: поузданост; ваљаност; онлајн настава; редовна настава; ученици; наставници.