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CORRELATIONS BETWEEN TEACHING STRATEGIES IN BIOLOGY, LEARNING STYLES, AND STUDENT SCHOOL ACHIEVEMENT: IMPLICATIONS FOR INQUIRY BASED TEACHING

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Abstract. *Research studies aimed at finding a more efficient model of teaching biology are still sporadic and inconsistent in the contemporary literature. The main aim of the research was to examine the correlation between the application of teaching strategies in biology teaching and students' school achievements, depending on how much the teacher respects their learning styles. The method of theoretical analysis and descriptive method were applied in the research. The sample consisted of 151 third-grade students (39.7% male and 60.3% female) of upper-secondary school. Kolb's Inventory of Learning Styles and Questionnaire for Assessing the Teaching Strategies of Biology Teachers were used as data gathering tools. Independent t-test, χ2 - square test, and One-way analysis of variance (ANOVA) were used to analyze data. The results showed that there was a statistically significant correlation between teaching strategies, learning styles, and students' school achievement in biology learning. At the same time, students perceived the applied teaching strategies differently, and manifested different dimensions of learning styles. This was followed by the conclusion that students achieved better school achievements in biology teaching when they were taught in the ways that corresponded to their learning styles, which pointed to certain implications for inquiry-based teaching, as well as in education of future biology teachers.*

Keywords: *descriptive method, inquiry-based teaching, learning styles, teaching strategies in biology, theoretical analysis*

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Introduction

In recent times, undoubtedly and under the influence of initiated educational reforms, the importance of the quality of teaching is increasingly emphasized. Educational reforms in the Republic of Serbia are stipulated within the Strategy for Education Development until 2027, which aim is to improve school curricula, synchronize them with the needs of the labor market, and connect them with the European Qualifications Framework. A lot of research in this field are aimed at discovering directions and possibilities for improving the learning process, especially in order to enable students to work independently and actively participate in the educational process, problem solving, and research. In the US National Science Education Standards (NSES) document (National Research Council 1996), scientific inquiry activities describe the processes or methods used by researchers. In other words, it describes an understanding of how science works, and how new information is generated through the research process (Shi et al., 2020). The research approach also redefines the correlation between goals, objectives, tasks, learning styles, teaching strategies, and educational standards, in the light of various programs for international assessment of student school achievements, such as: PISA (Program for International Student Assessment), TIMSS (Trends in International Mathematics and Science Study), as well as some others.

Approaches to knowledge acquisition based on transmission and reproduction are increasingly subject to criticism. Relevant research so far has shown that the research approach contributes to better school achievement, as well as to the problem solving and skills development for (laboratory) research work (Haury, 1993; McReary et al., 2006; Oliver-Hoyo & Allen, 2005; Oliver-Hoyo et al., 2004; Shymansky et al., 1990). In addition to school achievements, advantages of the research approach in teaching are reflected in the increase of student motivation, active approach to learning,

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and development of skills (Justice et al., 2009). The research approach also encourages students to develop critical thinking, thinking about their own learning, use of different sources of knowledge, as well as deeper understanding of basic concepts (Lane, 2007). Inquiry based teaching is represented in various (natural) disciplines, including physics (Fencl & Scheel, 2005; Heflich et al., 2001; McDermott 1995; Thacker et al., 1994;), chemistry (Jalil, 2006; Lewis & Lewis, 2005; Oliver-Hoyo et al., 2004; Oliver-Hoyo & Allen, 2005) and biology (Londraville et al., 2002). At the end of the 20th century, within the Biological Sciences Curriculum Study (BSCS), a teaching model called the BSCS 5E instructional model has been developed (Bybee et al., 2006).

In addition to research teaching strategies, another key term that has been studied is the learning style, i.e., the favorite way in which the student collects, processes, and adopts contents in order to use those (Grgić & Kolaković, 2010). Most definitions point to several determinants of learning styles: learning styles are personality traits that determine the consistency of a student's behavior; learning styles include cognitive, affective, and physiological aspects of an individual's functioning in a learning situation, the combination of which allows a unique approach to learning within predetermined categories; learning styles are the product of interaction between students and their physical and social environment (Keefe, 1987). Skehan pointed out that the learning style was "a characteristic way in which an individual decides on a particular approach to the task" (Skehan, 2001, p. 237). The learning style is "an established and dominant way of receiving, processing, and using stimuli in the learning process. It is the dominant way of mental presentation and processing of learning contents" (Bjekić & Dunjić-Mandić, 2007, p. 50).

The results of theoretical and empirical research have shown that there is a connection between student learning styles and the educational field (Olić, 2016; Olić & Adamov, 2016). Based on a review of available research, it can be concluded that students achieve higher school achievements when they are taught in the ways that are adapted to their preferred learning styles (Pritchard, 2009). The model of education based on respect for learning styles includes coordination of methods according to the established student learning style, adjustment of the work schedule to the needs of each individual, learning based of the rhythm of the student's work, true respect and recognition of students' individual distinctiveness and preferences (Willis & Hodson, 1999).

As it has been proven that awareness of students' learning style greatly enables the teacher to program teaching contents, select appropriate methods and teaching aids in the teaching process, encourage intrinsic motivation of students, and individualize teaching contents (Tubić, 2003), it is necessary to emphasize the pedagogical significance of awareness of and respect for students' learning styles through the application of optimal teaching (research) strategies in order to achieve better school achievements, and improve the quality of the educational process.

Field of Research

In the research-oriented learning, students are presented with a problem that they need to solve. From the students' viewpoint, inquiry is an active approach to learning that includes investigation of the surrounding world, which prompts the formulation of questions, discovering, and testing the findings to achieve deeper understanding (Sotakova et al., 2020). Colburn (2006) recommended focusing on the issues that involved experimental research, included materials and situations that students were familiar with, and which represented an optimal level of challenge to promote development of skills. As the repertoire of students' knowledge and skills has changed through research activities, it is common to talk about these processes as inquiry learning or inductive learning.

Based on the analysis of the goals of previous research, it has been noticed that the key role belongs to the teacher, and that the most important requirement is when the teacher sets aside enough time to engage students in a dialogue with the material world, in order to enable students to observe, examine, predict, discuss, and reflect data and evidence logically (National Research Council, 1996). In the classroom, each student should be provided with individualized access to content, with the opportunity to develop, articulate, and refine their own ideas (Harlen & Allende, 2009), which means that individual learning styles should be respected. It has also been found that teaching biology based on the concept of research-oriented learning encourages a "research style" of behavior, both by students and teachers. Students show a higher degree of confidence in explaining biological ideas, then writing and criticizing a laboratory report, as well as using scientific approaches to problem solving, including the use of analytical skills in order to perform experiments and general confidence for the course success (Baldwin et al., 1999). The results have shown that learning outcomes are much better if the teacher support (instruction in the role of guided inquiry) is appropriate (Lazonder & Harmsen, 2016).

The key concept of inquiry-based teaching is the instruction as such, i.e., different types of guidance by teachers. Researchers have sought to shed light on the effects of different types of leadership in the inquiry-based teaching

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and found that guided research has a number of advantages over open, non-leadership research (Carolan et al., 2014; D'Angelo et al., 2014; Lazorden & Harmisen, 2016). Students who have some kind of guidance are better able to solve tasks, more successful in gathering current information and better in achieving results on learning tests after the research work. The instructions are equally useful for students of different ages and enable more efficient involvement of students in forms of research and learning. The key approaches to leadership in the inquiry-based teaching, identified by different researchers, are shown in Table 1.

Table 1
Key Approaches to the Inquiry Based Teaching (Chowdhury, 2016)

Researchers	Year of Publication	Approaches to Leadership in the Inquiry Based Teaching
Banchi & Bell	(2008)	Teachers should provide different levels of guidance: structured, guided, and open research.
Ku et al.	(2014)	Teachers must provide more than one instruction in order to develop critical thinking in order to optimize learning outcomes.
Wilhelm	(2014)	Teachers need to learn how to ask their students essential questions in order to encourage them to critical thinking and innovation.
Ireland et al.	(2012)	Students participating in the research should be able to independently discover the answers through their own active engagement and gaining new experiences.
Buckner & Kim	(2014)	Although related to difficulties, modern technologies need to be incorporated into the process of optimizing inquiry-based teaching.
Marriott	(2014)	Students are much better influenced by teachers who often ask questions than by teachers who mainly teach (transfer knowledge).
Marshall & Horton	(2011)	Student research should be conducted before receiving explanations by the teacher.
Brown	(2012)	Two important aspects of promotion of the inquiry-based teaching are the following: asking essential questions and fostering focused discussion.
Hermann & Miranda	(2010)	Open research question templates encourage students to actively participate in the research.

The inquiry-based approach can lead to the desired changes in educational work and increase the quantity and quality of students' knowledge of biology, better content retention, optimal cognitive load, respect for their individual differences and learning styles, as well as greater motivation to learn complex contents.

Considerations of relevant research point to the statement that respecting learning styles and adopting different teaching strategies, as well as expanding their repertoire, affect more efficient use of different sources of knowledge in students, management of cognitive processes, as well as efficiency and quality of teaching in general. In that sense, it is necessary for the teacher to know learning styles of his/her students in order to be able to optimally select corresponding teaching strategies. Such research in the field of natural sciences, and especially biology, is still insufficient.

Research Focus, Research Aim, and Research Questions

Respecting individual differences among students, the teacher should keep in mind that his/her class consists of individuals who require different methods and strategies that are consistent with different learning styles. During class, the teacher should strive to activate each student by using available materials, arousing their curiosity and motivation for the content studied. This research sought to point out the pedagogical importance of knowing and respecting the learning style through the selection of appropriate teaching (research) strategies that corresponded to them in biology teaching, in order to achieve better school achievements and improve the quality of the educational process.

The aim of the research was to examine the correlation between the application of teaching strategies in biol-

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ogy teaching and student school achievements, depending on how much the teacher respects their learning styles.

Specifically, this research focused on the answers to the following research questions:

1. 1. Is there a correlation between the identified teaching strategies in biology teaching and student school achievement?
2. 2. Are there differences between respondents of different genders in the perception of teaching strategies in biology teaching?
3. 3. Is there a correlation between the identified learning styles of students and teaching strategies in biology teaching?
4. 4. Are there differences between students of different genders in terms of dimensions of a learning style?
5. 5. Are there differences in the school achievement in biology teaching between students for whom teaching strategies are aligned with their learning styles and students for whom this is not the case?

Research Methodology

Research Design

The design of the research has been based on axiological assumptions and personality models according to which a person is a complete, self-conscious, unique, unrepeatable, authentic individual of autonomous behavior with a freedom of choice. In accordance with the presented starting points, a holistic approach stands out as an appropriate methodological approach. A holistic perspective of learning is offered by the theory of experiential learning developed within the humanistic paradigm. Constructivism is proposed as an optimal theoretical framework, which fully explains and supports the concept of directions of active teaching. Constructivist learning is based on the student's active participation in problem solving and critical thinking marked as a learning activity and "construction" of knowledge (Milutinović, 2005). Investigators in the field of cognitive learning believe that active and authentic construction of knowledge results in a deeper understanding of the material learned and reveals new aspects about how people learn (Bransford, et al., 2000).

The humanistic educational paradigm affirms gradual takeover of the learning process by students, as well as the collaborative climate and cooperative learning. E. Johnson (2002) has had a similar approach to contextual teaching and learning, which incorporate two components of this system: self-regulated learning and cooperation. According to her, self-regulated learning is characterized by active and independent research, which implies connecting academic studies and everyday life. Self-directed and cooperative learning are positioned in the new educational paradigm as important indicators of the quality of education.

During this research, the method of theoretical analysis was applied (consideration of results of previous relevant research on the correlation of the mentioned variables), as well as the descriptive method, and the method of statistical analysis. The research was conducted in the second semester of the school year 2019/20.

Sample

The selection of school for the research was made on the basis of the existence of appropriate conditions for the research implementation, taking into account the fact that the research results are affected by the ethos of the school, its level of equipment with teaching aids and information technologies, environment in which the school is located (city), demographic properties of the teachers (gender, age, years of service, type and level of qualifications), and especially the quality level of the working climate in the school (observed measure in which the principal supports the autonomy of employees.

The sample included 151 third-grade students (39.7% male and 60.3% female) of the upper-secondary school "Svetozar Markovic" from Novi Sad (Serbia), during the second semester of the school year 2019/20. In relation to the stated number of students, 70.1% of students had excellent results in biology, 29.2% of students had very good results, while 0.7% of students achieved good results. There were no students with sufficient or insufficient school achievement when it came to the achievement in biology. A great percentage of the respondents' parents (96.37% of fathers and 93.61% of mothers) had secondary or higher education, which means that the socio-educational status of both parents was favorable. The social background was also favorable for the respondents included in the sample, viewed as a whole, because 64.41% of the respondents originated from the families of civil servants with secondary education and professionals with higher education, while 32.39%

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of the respondents originated from the families of workers. Only 3 respondents (0.83%) originated from the family dealing with agriculture.

Concerning the sample size, it was determined according to the Raosoft Sample Size Calculator application (http://www.raosoft.com/samplesize.html), and was supposed to include 258 respondents. However, due to specific conditions of the organization of teaching in the Republic of Serbia in the second semester of the school year 2019/20 (COVID-19 pandemic), the research was adjusted to the given circumstances and conducted in compliance with all prescribed epidemiological measures. This means that the number of respondents was decreased (due to the high number of infected and students who were in isolation). In addition, there were considered only those respondents who completed both instruments.

According to the sample type, this was a deliberate sample. It was estimated that the sample size, thus reduced due to the pandemic and limited testing options, met the criteria of the selected research draft and appropriate consideration of the examined facts and effects of the research. It was evident that there was no complete theoretical justification for generalization of the results obtained on such a sample, but it could undoubtedly be used efficiently in the exploratory research. The generalizations that were made should be observed within the framework of this specific research and shedding light on the examined problem.

With reference to respecting ethical procedures, during the implementation of the research, the authors respected provisions of the Code of Academic Integrity of the University of Novi Sad, especially Art. 7, which referred to scientific and research work with respondents (UNS, 2020, p.3). The authors also obtained ethical approval for the research, i.e., a written approval for the research given by the director of the Department of Biology and Ecology of the Faculty of Science, University of Novi Sad, and the school principal. Additionally, students were informed about the ethical procedures, and they were included in the research voluntarily.

Instrument Development: Reliability and Validity

The following instruments were used to collect data in this study: Kolb's *Inventory of Learning Styles* and *Questionnaire for Assessing the Teaching Strategies of Biology Teachers*. Kolb's Learning Style Inventory (LSI, version 3.1, Kolb, 2010) was used to assess the preferred learning style of each respondent. The applied instrument was constructed in such a way that it assessed the representation of four phases of the learning cycle. The learning cycle ranged from concrete experience to observation and its reflection, through the creation of an abstract concept and generalizations to the testing of hypotheses in future situations. The following four learning styles were based on this four-step cycle: concrete experience (CE), abstract conceptualization (AC), active experimentation (AE), and reflective observation (RO). The questionnaire consisted of 12 items to which respondents responded by ranking the offered answers, writing a number from one to four in the order in which the item best describes the individual learning style (1 – least related to the respondent, 4 - most related to the respondent). Values ranging from 12 to 48 were obtained by adding the scores. Based on the given answers, the degree of individual inclinations towards each phase of the learning cycle was determined for each individual. In the next step, the preferred learning style was determined by calculating the difference between the AC-CE and AE-RO scores: divergent (DI), accommodating (AC), convergent (CO) or assimilating style (AS). The Cronbach alpha reliability coefficient for the subscale Concrete Experience was .77, .81for Reflective Observation (RO), .84for Abstract Conceptualization (AC), and .80 for Active Experimentation (AE) (Kolb, 2005).

The questionnaire for the assessment of teaching strategies of biology teachers was a modified version of the Scale for the assessment of teaching strategies (Olić, 2016), expanded with eight statements, and adapted to the biology teaching. This instrument included a total of 32 short statements that contained a description of the teaching strategy of teachers applied in biology class and formulated on the basis of previous relevant research on inquiry-based teaching (Table attached in Annex). Respondents answered the questions in the instrument by circling the number on a 5- point Likert scale, in accordance with the degree of their agreement with the stated statement. The obtained scores indicated the teaching strategies used by biology teachers in class. Based on theoretical studies and the applied Kolb Inventory of learning styles, the following learning styles have been determined: divergent (DI), accommodating (AC), convergent (CO), and assimilating (AS). The following teaching strategies (subscales in the instrument) would correspond to these learning styles: ACTS - accommodating teaching strategy; DITS - divergent teaching strategy; COTS - convergent teaching strategy; ASTS - assimilative teaching strategy.

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This instrument was additionally tested to determine metric properties. The following results were obtained: the average values (arithmetic mean) of the items from the *Questionnaire for the assessment of teaching strategies of biology teachers* ranged between M = 2.72 and M = 4.36, which classified them as "medium easy", and indicated a well-balanced questionnaire. The Crombach alpha coefficient (α) was above .70, which indicated the high reliability of all 32 items of the instrument (α = .924 to α = .936). The discriminant index was calculated for all items of the questionnaire. The discriminant index higher than .40 indicated excellent discrimination, .30 - .39 indicated good discrimination, a value of .20 to .29 indicated acceptable discrimination, while lower values indicated poor discrimination. Three items of the questionnaire had a negative index of discrimination: *The teacher rarely encourages us to think about what we learn* (- .036); *The biology teacher does not organize group work* (- .053); *and The teacher does not insist on the practical use of ideas and theories* (- .312).

It was noticed that these items were the items with reversible scoring. Also, there was checked the discriminant value for these items before reversible scoring (i.e., with original scores). The index of discrimination was still very low (.120; .112; .09, respectively). Based on these results, the items were omitted from further analysis. Other items had discriminants ranging from .205 to .695. A total of 26 items had an excellent discriminant index (higher than .40). The discriminant index for 2 items was in range of .30 - .39, which put them in the category of items of good discrimination, and only one item had an acceptable index of discrimination.

Procedure

After the required permissions, which were obtained from the Department of Biology and Ecology of the Faculty of Sciences, University of Novi Sad, and the principal of the upper secondary school "Svetozar Marković" from Novi Sad, the research instruments were prepared for the research. Prior to the research, the students were informed about the nature and goals of the research, as well as about their role in the research. The *Inventory of Learning Styles* and *Questionnaire for Assessing the Teaching Strategies of Biology Teachers* were applied with standard guidelines in classrooms, and each session took 20 minutes. Data collection was done by the subject teachers who had been informed by the researchers about the study. Incomplete or incorrectly marked *Inventory of Learning Styles* and *Questionnaire for Assessing the Teaching Strategies of Biology Teachers* were not taken into consideration.

Data Analysis

Within the statistical data processing, frequencies (*f*), percentages (%), mean value / arithmetic mean (*M*) were used to describe the parameters of importance, depending on their nature. Standard deviation (*SD*) was used as a measure of deviation from the average. The uniformity of the GPA of students and grades in biology at the end of semester of the third grade of upper secondary school was analyzed by calculating and analyzing average values: arithmetic mean (*M*), standard deviation (*SD*), χ^2 - square test, and independent *t-test.* One-way analysis of variance (ANOVA) and *t* - test for large independent samples were used to test for differences. The χ^2 square test examined the mutual correlation between two categorical variables. The correlation of the two numerical variables was tested with Pearson's correlation coefficient.

Statistical processing and analysis were done in the statistical package SPSS ver. 25.0 (Statistical Package for the Social Sciences) for Windows. To determine the metric properties of the research instruments, the following were applied: discriminant index, reliability index, calculated item weight and questionnaire dimensionality with the application of the Analysis of the main components (Direct Oblimin rotation).

Research Results

Correlation of Teaching Strategies and School Achievement of Students in Biology Teaching

Within the first research question, it was sought to determine which teaching strategies were most often used by biology teachers in teaching, and whether there was a correlation with students' school achievement in biology. Descriptive indicators of the subscales of biology teacher work strategies are shown in Table 2:

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Table 2
Descriptive Indicators of the Subscales of Teacher Work Strategy

Teaching strategies	*N*	*Min*	*Max*	*M*	*SD*
COTS	151	1.29	5.00	3.47	.78
ASTS	149	1.43	5.00	3.55	.75
ACTS	150	1.25	5.00	3.62	.78
DITS	148	1.29	5.00	3.76	.77

Note. *N*-a number of respondents; *Min*-minimum value on the sample; *Max*-maximum value on the sample; *M* – arithmetic mean; *SD*-standard deviation; COTS - convergent teaching strategy; ASTS - assimilative teaching strategy; ACTS - accommodating teaching strategy; DITS - divergent teaching strategy.

Theoretical minimum and maximum on the subscales of the questionnaire examining the work strategies of biology teachers ranged from 1 to 5. The average values ranged from $M = 3.47$ for convergent teaching strategy (COTS) to $M = 3.76$ for divergent teaching strategy (DITS).

Concerning the correlation of teaching strategies and the school achievement of students, the results are shown in Table 3.

Table 3
Correlation between the Subscales of Teaching Strategies and School Achievement of Students

Teaching Strategies		School Achievement of Students
COTS	*r*	- .196*
	p	.018
ASTS	*r*	- .168*
	p	.045
ACTS	*r*	- .090
	p	.284
DITS	*r*	- .013
	p	.879

Note. *r*- Pearson's correlation coefficient; *p* – statistical significance; *Statistical significance on the level .05; COTS - convergent teaching strategy; ASTS - assimilative teaching strategy; ACTS - accommodating teaching strategy; DITS - divergent teaching strategy.

Pearson's correlation coefficient was applied to examine whether teaching strategies were statistically significant in relation to students' school achievement. There was statistically significant negative correlation of the school achievement on one side of the subscales: COTS ($r = -.196$, $p = .018$), and ASTS ($r = -.168$, $p = .045$) on the other side. Thus, the more the teacher applies the convergent teaching strategy (COTS) and the assimilative teaching strategy (ASTS), the lower the student's school achievement.

It was also sought to find out if there were differences between students in the perception of teaching strategies of biology teachers regarding gender of the respondents (second research question). The subscales showing the teaching strategies and gender of the respondents are presented in Table 4:

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Table 4
Subscales of Teaching Strategies and Gender of Students

Teaching strategies	Gender	*N*	*M*	*SD*	*t*	*df*	*p*
COTS	Male	60	3.65	.78	2.383	149	.018
	Female	91	3.35	.76			
ASTS	Male	59	3.72	.77	2.200	147	.029
	Female	90	3.45	.72			
ACTS	Male	59	3.70	.81	1.003	148	.318
	Female	91	3.57	.76			
DITS	Male	58	3.83	.72	0.896	146	.372
	Female	90	3.72	.82			

Note. *N*-number of respondents; *M* – arithmetic mean; *SD*-standard deviation; *t*-t test for large independent samples; *df*-degrees of freedom; *p*-statistical significance; COTS - convergent teaching strategy; ASTS - assimilative teaching strategy; ACTS - accommodating teaching strategy; DITS - divergent teaching strategy.

According to the obtained research findings, it could be stated that respondents of different genders statistically significantly differ in the perception of representation of convergent teaching strategies (COTS) ($t = 2.383$, $p = .018$), and assimilative teaching strategies (ASTS) ($t = 2.200$, $p = .029$) in biology teaching. Male respondents more believed that the convergent teaching strategy (COTS) was prevalent among biology teachers than female respondents (3.65 ± .78 vs. 3.35 ± .76). The same was true for the assimilative teaching strategy (ASTS), which was considered to be more represented by male than by female respondents (3.72 ± .77 vs. 3.45 ± .72).

Respondents of both genders agreed on representation of the accommodating teaching strategy (ACTS) and the divergent teaching strategy (DITS) in work of biology teachers.

Student Learning Styles and Correlations with Teaching Strategies in Biology Teaching

Within the third research question, it was sought to identify student learning styles and examine their correlation with teaching strategies in biology.

Dimensions of the learning style (descriptive indicators) and learning styles of the respondents are shown in Tables 5 and 6:

Table 5
Dimensions of Learning Styles – Descriptive Indicators

Dimensions of learning styles	*N*	*Min*	*Max*	*M*	*SD*
Concrete experience (CE)	151	12.00	38.00	23.32	5.31
Reflexive observation (RO)	151	19.00	43.00	30.42	4.90
Abstract conceptualization (AC)	151	18.00	48.00	34.24	5.16
Active experimentation (AE)	151	16.00	48.00	32.02	5.61
Observation of information (AC_CE)	151	-18.00	36.00	10.92	9.13
Processing of information (AE_RO)	151	-25.00	24.00	1.60	9.20

The theoretical minimum and maximum of four dimensions: concrete experience (C), reflective observation (RO), abstract conceptualization (AC) and active experimentation (AE) ranged from 12 to 48.

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Table 6
Learning Styles – Descriptive Indicators

Learning style	Frequency (*f*)	Percentage (%)
Convergent	78	51.7
Assimilative	56	37.1
Accommodating	11	7.3
Divergent	6	4.0
Total (Σ)	151	100

It could be concluded that the convergent learning style was the most common among students. 51.7% of students had this learning style, then 37.1% of them had the assimilative learning style, only 7.3% of them had the accommodating learning style, while the divergent learning style was expressed by the smallest percentage, 4% of respondents.

Regarding the correlation of the dimensions of students' learning style and the teaching strategy of biology teachers, the findings are shown in Tables 7 and 8:

Table 7
Subscales of Teaching Strategies and Dimensions of Students' Learning Styles

Dimensions of learning styles		COTS	ASTS	ACTS	DITS
Concrete experience (CE)	*r*	- .090	- .133	- .195*	- .128
	p	.272	.107	.017	.120
Reflexive observation (RO)	*r*	- .174*	- .139	- .089	- .135
	p	.033	.090	.278	.102
Abstract conceptualization (AC)	*r*	.023	.091	.083	.057
	p	.781	.270	.313	.489
Active experimentation (AE)	*r*	.216**	.164*	.187*	.186*
	p	.008	.046	.022	.024

Note. *r*- Pearson's correlation coefficient; *p* – statistical significance; COTS - convergent teaching strategy; ASTS - assimilative teaching strategy; ACTS - accommodating teaching strategy; DITS - divergent teaching strategy; * $p < .05$, ** $p < .01$.

Correlation between teaching strategies and the students' learning styles has pointed to the following:

- Active experimentation is in a statistically significant positive correlation with all teaching strategies: COTS ($r = .216$, $p = .008$), ASTS ($r = .164$, $p = .046$), ACTS ($r = .187$, $p = .022$), and DITS ($r = .186$, $p = .024$).
- Reflexive observation is in a statistically significant negative correlation with the teaching strategy COTS ($r = - .174$, $p = .033$). Thus, the more pronounced the COTS strategy in the teacher, the lower the score on reflexive observation as learning style (and vice versa).
- The concrete experience is in a statistically significant negative correlation with the teaching strategy of ACTS ($r = - .195$, $p = .017$). Thus, the more pronounced the ACTS strategy in the teacher, the lower the score on the concrete experience as a learning style (and vice versa).

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Table 8
Subscales of Teaching Strategy and Students' learning Styles

Learning style		COTS	ASTS	ACTS	DITS
Convergent	*M*	3.55	3.61	3.70	3.87
	SD	.78	.70	.72	.70
Assimilative	*M*	3.38	3.55	3.60	3.70
	SD	.74	.75	.70	.75
Accommodating	*M*	3.36	3.38	3.24	3.51
	SD	1.01	.98	1.27	1.04
Divergent	*M*	3.45	3.29	3.44	3.45
	SD	.86	1.10	1.07	1.33
Total	*M*	3.47	3.56	3.62	3.76
	SD	.78	.75	.78	.78
F		.606	.577	1.295	1.294
p		.612	.631	.278	.279

Note. *M* – arithmetic mean; *SD*-standard deviation; *F*- One-factor analysis of variance (ANOVA); *p*-statistical significance; COTS - convergent teaching strategy; ASTS - assimilative teaching strategy;
ACTS - accommodating teaching strategy; DITS - divergent teaching strategy.

It was also examined if there was a difference between students with different learning styles in the perception of biology teacher strategy. The statistical significance of this test did not exceed the limit value of $p < .05$, which indicated that there were no statistically significant differences.

Regarding the connection between the dimension of students' learning style and gender of respondents, the results are shown in Table 9:

Table 9
Dimensions of Learning Styles and Gender

Dimensions of learning styles	Gender	*N*	*M*	*SD*	*t*	*df*	*p*
Concrete experience (CE)	Male	60	22.28	5.77	- 1.961	149	.053
	Female	91	24.00	4.90			
Reflexive observation (RO)	Male	60	29.38	4.58	- 2.143	149	.034
	Female	91	31.11	5.01			
Abstract conceptualization (AC)	Male	60	36.10	5.10	3.757	149	0.001
	Female	91	33.01	4.84			
Active experimentation (AE)	Male	60	32.3	6.05	.379	149	.706
	Female	91	31.88	5.33			

T test for large independent samples was used to examine whether respondents of different genders had different average values on the dimensions of learning style (fourth research question). The indicators supported the statement that female respondents had on average higher values achieved on reflexive observation ($M = 31.11 \pm 5.01$) compared to male respondents ($M = 29.38 \pm 4.58$), ($t = 2.143$, $p = .034$). On the other hand, male respondents had higher values on abstract conceptualization ($M = 36.10 \pm 5.10$) compared to female respondents ($M = 33.01 \pm 4.84$), ($t = 3.75$, $p = .001$). There was no statistically significant difference in the other dimensions.

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Compliance of Teaching Strategies with Learning Styles and School Achievements of Students in Biology Teaching

Within the fifth research question, the interest was expressed towards the extent to which teaching strategies were coordinated with the students' learning style. The obtained indicators indicated that only 28 (18.5%) students had a coordinated learning style with the teaching strategies of biology teachers. In the remaining 81.5% of students, the learning style was not in line with teaching strategies preferred by biology teachers.

Regarding the consistency of learning style with teaching strategies and school achievements in biology, the results of the research are shown in Table 10:

Table 10
Consistency of Learning Style with Teaching Strategies and School Achievements in Biology

	Gender	*N*	*M*	*SD*	*t*	*df*	*p*
Consistency	Do not match	120	4.24	0.87	2.482	143	.014
	Match	25	4.60	0.62			

Students who matched and those who did not match the learning style with the teaching strategy preferred by their biology teachers statistically significantly differed in the GPA in biology ($t = 2.482$, $p = .014$). Those whose style matched the strategy (4.60 ± .62) had a higher GPA compared to those students whose style did not match the teaching strategy (4.24 ± .87).

Discussion

The obtained results should be analyzed and interpreted carefully and cautiously because it was a small sample, which was very heterogeneous in terms of a cognitive style, learning style, reception and processing of information, motivation, levels of aspiration, and many other factors that undoubtedly affected the learning process and school achievements. The results of the research showed that the average values of teaching strategies of biology teachers ranged from $M = 3.47$ (COTS) to $M = 3.76$ (DITS). This means that biology teachers generally have different strategies, with a distinguished divergent teaching strategy (DITS), which is characterized by the following teaching activities: looking at problems from different angles, using different sources of knowledge, group work, problem solving, discussion, etc. This is followed by the accommodating teaching strategy (ACTS) ($M = 3.62$), which enables independent work of students, mainly from a direct experience (practical work, field work, observation), as well as testing one's own ideas and hypotheses. This is followed by the assimilating teaching strategy (ASTS) ($M = 3.55$), which prefers an inductive path of cognition, example analysis, problem solving step by step, connecting key concepts into a meaningful whole, emphasizing rationality and logic, most often via lectures. The lowest representation is in the convergent teaching strategy (COTS) ($M = 3.47$), which mostly enables the research approach: students are encouraged to research in the text, on models and graphs, computer simulations, etc. They solve tasks on instruction sheets, perform experiments, work in the field and in the laboratory, set hypotheses, check results of their work, present them visually in tables and graphs, etc. The deductive way of cognition is followed in the learning process.

Students with a divergent learning style (DI) are characterized by a tendency to observe and perceive details, imagination, fluency of ideas, flexibility, and tendency to function under time pressure. The biggest difficulty with these students is their passivity, so the task of the teacher is to continuously motivate them (Tubić, 2003). On the other hand, the accommodator (AC) is slower in designing the contents at the logical level and faster in active application. The accommodator (AC) is ready to take risks and make mistakes, not accepting a mistake as an indicator of failure. The phase of receiving information is short for the accommodator, and he should be given tasks that require activity, while the sequences in the teaching material should be shorter and more numerous (Bjekić & Dunjić-Mandić, 2007). Assimilative (ASTS) and convergent teaching strategies (COTS) are most suitable for students with assimilative (AS) and convergent (CO) learning styles. Assimilator (AS) is systematic, analytical, fast in designing contents at the logical level of thoughts, ready for induction of thoughts and formation of conclusions, prone to learning by means of through research and asking questions. Convergent (CO) is prone to deduction, hypotheti-

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cally solves problems, is prone to experimentation, teamwork. Apparently, assimilators and convergences are the students who prefer the research approach in biology teaching.

There were significant differences between respondents of different genders in relation to the perception of the representation of teaching strategies. Namely, male respondents believed that convergent (COTS) and assimilative teaching strategy (ASTS) were more prevalent among biology teachers than it was believed by female respondents. Regarding the representation of accommodating (ACTS) and divergent teaching strategies (DITS) in the work of biology teachers, respondents of both genders agreed in the same way.

Based on the research results, it could be emphasized that the convergent learning style is the most common among students. 51.7% of students have this learning style, then 37.1% of them have the assimilative style, only 7.3% of students have the accommodating learning style, while the divergent learning style is expressed by the smallest percentage of respondents with only 4%. Active experimentation (AE), as a dimension of learning style, is in a statistically significant positive correlation with all teaching strategies: COTS ($r = .216$, $p = .008$), ASTS ($r = .164$, $p = .046$), ACTS ($r = .187$, $p = .022$), and DITS ($r = .186$, $p = .024$). Research findings also indicate the emergence of a negative correlation, namely the dimension of learning style such as: reflective observation (RO) and concrete experience (CE): reflective observation (RO) is in statistically significant negative correlation with the teaching strategy COTS ($r = -.174$, $p = .033$), while concrete experience (CE) is in a statistically significant negative correlation with the teaching strategy ACTS ($r = -.195$, $p = .017$). Thus, the more pronounced the convergent (COTS) and accommodating teaching strategy (ACTS) is in the teacher, the lower the score on the concrete experience as a learning style (and vice versa).

When it comes to the correlation of the dimensions, learning style of students, and their gender, indicators support the conclusion that female respondents have on average obtained higher values on reflexive observation (RO) ($M = 31.11 \pm 5.01$) compared to male respondents ($M = 29.38 \pm 4.58$), ($t = 2.143$, $p = .034$). On the other hand, male respondents have obtained higher values on abstract conceptualization (AC) ($M = 36.10 \pm 5.10$) compared to female respondents ($M = 33.01 \pm 4.84$), ($t = 3.75$, $p = .000$). There is no statistically significant difference on the other dimensions.

When it comes to coordination of teaching strategy and learning style, it could be stated that as many as 81.5% of respondents do not have coordinated learning style with the teaching strategies preferred by the teacher. Since the research findings indicate that the respondents whose style matches the strategy ($4.60 \pm .62$) have a higher average grade (GPA) compared to those students whose style does not match the teaching strategy ($4.24 \pm .87$), it is necessary to point out to teachers the need to identify the learning style of students and plan the selection of corresponding teaching strategies.

Implications for Practical Work in Biology Teaching

Empirical research on learning styles has shown that the very awareness of the presence of different learning styles and ways of work suitable to a particular student causes positive changes in the work of both students and teachers (Blackmore, 1996, according to: Tubić, 2005). A key factor in planning and implementation of teaching is the understanding of how students learn, i.e., understanding and respecting of their learning style. Learning styles can vary depending on the student's physiological preferences, his/her emotional, social, and psychological preferences, as well as the learning environment (Dunn et al., 2009). Coordination of the teachers' teaching style with the students' learning style results in better school achievements of students, i.e., longer retention of information, their more efficient application, more positive attitudes towards the teaching subject and learning in general (Tubić, 2005).

The more diverse and developed cognitive processes are, the more flexible and diverse students' learning styles will become, which enables their modification. This knowledge is important for teachers because it allows them to use a variety of methods and procedures in their work, which further opens up opportunities for more students to find and use their "strengths", or ways of learning that suit them best.

Concerning the importance of knowing and respecting the learning style of students, the authors Dryden and Vos have emphasized the following: "Analyze the learning style of each student and provide him/her with appropriate stimuli. If you do that, you will be surprised at how easily people learn and how much less resistance you will encounter "(Dryden & Vos, 2001, p. 363). Willis and Hodson have offered a model of education based on learning style, which starts from the belief that students are capable and that their potential is unlimited. The

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model of education based on respect for learning styles includes coordination of methods and work programs according to the established student's learning style, adjusting the work schedule to the needs of each individual, implements learning taking into account the student's rhythm of work, true respect and recognition of individuality and student preferences (Willis & Hodson, 1999).

The class represents a community of different individuals according to numerous parameters, and not every teaching strategy corresponds to every student. In addition, learning styles of individual students are intertwined, and although one of them is dominant, the existence and influence of other styles, i.e., their dimensions, cannot be denied. Despite the diversity and complexity of this issue for teaching practice, familiarity with students' learning styles has significant implications for educational work and improvement of the quality of teaching. Familiarity with learning styles enables all stakeholders in the educational process to recognize and understand differences that exist among students in terms of information reception and processing, which allows better understanding of their school achievement. The collected knowledge provides an opportunity for teachers to more meaningfully select and combine teaching methods, forms, means and techniques, to continuously monitor and respect individual differences of students in the course of the teaching process.

In light of the research results, implications for the work of biology teachers have taken into account the identified preferred learning styles of students, with the emphasis on active experimentation (AE), as a dimension of learning style that is in statistically significant positive correlation with all teaching strategies. When it comes to specific teaching strategies in biology that support inquiry-based teaching, respecting student learning styles, the following are some of the recommendations for teachers.

Recommendations for the teachers how to work with the students who prefer the divergent (DI) learning style:

- Encourage students to present their ideas (opinions) and respect them;
- Evaluate students' efforts and work continuously (not only at the end of the trimester / semester / school year);
- Connect what students learn in biology classes with the teaching material of other subjects (e.g., Chemistry, Geography, Physics, etc.);
- Encourage students to use different sources of knowledge: books, textbooks, the Internet, etc. Use resources beyond classroom/school;
- Encourage students to observe problems in the teaching material from different angles.
- Regularly inform students whether they have done something well or not.
- Organize often group work.
- Pose problems for which a solution is reached by considering different ideas.

Recommendations for the teachers how to work with the students who prefer the accommodating (AC) learning style:

- Encourage students to help each other and cooperate in order to solve a problem.
- Often analyze topics that are interesting and challenging to students, not just those from the textbooks.
- Assign to students a task or a problem, from which they see the benefit in everyday life (e.g., to protect our health, to preserve the environment, etc.);
- Explain the teaching material in an interesting way; confront ambiguous findings and ask questions;
- Often organize work of students in small groups, in pairs or on a joint problem-solving.
- Often represent learning from a direct experience (practical work, field work, observation). Collect student responses.
- Explain the teaching material with real-life examples. More emphasis on "how we have come to know," less on "what we know".

Recommendations for the teachers how to work with the students who prefer the convergent (CO) learning style:

- Encourage the research of students in the text, on the model, graphs, microscopes, dissection, observation, etc.
- Encourage students to present and interpret the results of their work visually as well: on graphs, tables, slides.
- Often give worksheets or instruction sheets and work orders to students;
- Use not only the textbook, but also the computer, presentations, video clips, brings models, etc.

https://doi.org/10.33225/jbse/21.20.184

- Perform experiments, tests, simulations, etc. Structure investigations;
- Insist on the practical use of ideas and theories. Apply what has just been learned in class or reading to solve a problem.
- During the presentation of the teaching material, first present examples and then explain a definition;
- Pose problems that have not a unique and logical solution.

Recommendations for the teachers how to work with the students who prefer the assimilating (AS) learning style:

- Encourage students to solve the tasks step by step.
- Encourage students to think about what they learn.
- Encourage the connection of key concepts into a meaningful whole. Construct correlation and create metaphors.
- Often encourage students to evaluate the results of their work on their own (research checklists that students fill out during class, portfolio, work reports, self-evaluation of students' school achievements, etc.);
- Encourage students to ask questions and anticipate solutions to the problems.
- Enable each student to work independently and learn at his own pace.
- First give examples to students and then explains the given concept.

Involving students in inquiry is an effective way to help them learn to think critically, to be developed as self-directed learners, and acquire a profound understanding of specific topics (Tsybulsky et al., 2020).

This study provides valuable knowledge regarding the development of an inquiry-based teaching and the inclusion of this approach in teacher education programs. Many authors have pointed to the need to educate teachers with an inquiring attitude (Baan et al., 2020). More analytical and research-oriented skills are supposed to be needed for developing "new forms of teaching and learning for the future" (Niemi & Nevgi, 2014, p.131). In future research, observations could be performed in order to get more insight into teachers´ preparation for inquiry-based teaching, students' learning styles and teaching strategies.

This and similar research have certain limitations arising from different theoretical starting points and methodological approaches (paradigms), the nature of the studied phenomena, application of particular research procedures, properties of applied instruments, complexity of coordination structure and interdependence of phenomena in the field of education, especially due to subjectivity of the very respondents. The most controversial issues are issues of interpretation, i.e., issues of (im)possibility to generalize results, and uniqueness (impossibility to reconstruct identical situations). However, it should not be forgotten that such research enables expansion of the application of research procedures and instruments to the field of teaching in which there is a large number of complex variables, as well as to point out their mutual correlation.

There is no doubt that the exactness of pedagogical research has been influenced by numerous epistemological, phenomenological, epistemological-methodological, ethical, emotional, and other factors. Therefore, this research should be understood as relatively exact, with all its advantages and disadvantages.

Conclusions

Based on the conducted research, it can be concluded that there is a correlation among students' learning styles, different teaching strategies applied by the biology teacher, and the school success of upper secondary school students. There is a very small percentage of respondents whose learning style is aligned with the teaching strategies preferred by the biology teacher (18.5%), compared to the remaining 81.5% of respondents whose learning style does not correspond to the applied teaching strategies. This is reflected on the school success of upper secondary school students, because students whose learning style corresponds to the applied teaching strategies achieve significantly better school achievement than the students for whom this is not the case. There are differences between respondents of different genders in the perception of teaching strategies in teaching biology, but not in terms of perception of the learning style dimensions. These results indicate that it is necessary to apply as diverse strategies as possible in the teaching process in order to meet the needs of as many students as possible. Respect for the cognitive style and learning style of students implies that the teacher, respecting individual differences among students, has in mind that his/her class consists of individuals who have very different educational needs.

Based on the results of this research, implications for the practical work of biology teachers have been offered,

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respecting the properties of particular learning styles. In order for the teacher to succeed in his/her efforts, it is necessary to know both properties of learning styles and properties of cognitive styles, which implies continuous learning and improvement within this topic. As learning styles are subject to change, the teacher should follow the students through the process of their growth and development, in order to establish a timely connection between the teaching process and the new changes. It is very important that the teacher applies inquiry teaching strategies, which enable students to take an active role in the teaching process, inductive-deductive way of learning, experimentation, problem solving, critical thinking, etc.

This research opens possibilities for further studies of learning styles (as unavoidable variables) and teaching strategies, and there is no doubt that it has significant implications for the education system of biology teachers and strengthening their competencies for inquiry-based teaching.

Based on the presented facts, the general conclusion is that being familiar with students' learning styles enables selection of appropriate teaching strategies, facilitates the adaptation of teaching to individual properties of students, and contributes to their better school achievement, including rationalization and optimization of biology teaching.

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Annexes:

Table: Key approaches to research-oriented learning and relevant claims (for the Questionnaire for Teaching Assessment of Biology Teachers)

No.	Current key approaches to research-oriented learning identified by different researchers	Statements
1.	The teacher asks questions and encourages interaction among students (Postman & Weingarten, 1980).	The teacher encourages us to help each other and to cooperate when we solve a problem. (ACTS)
2.	Teacher's support during research-oriented learning - leadership strategies (Spronken-Smith & Walker, 2010). Teachers should provide different levels of guidance: structured, guided, open research (Banchi & Bell, 2008)	The teacher encourages us to solve the tasks step by step. (ASTS)

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No.	Current key approaches to research-oriented learning identified by different researchers	Statements
3.	The freedom and initiative of students in the learning process is encouraged and respected (Brooks & Brooks, 1999).	In biology class, we often analyze topics that are interesting and challenging to us, not just those from the textbooks. (ACTS)
4.	Two important aspects of the research learning promotion are the following: asking questions to stimulate thought activities and fostering a focused conversation (Wilhelm, 2014; Brown, 2012). The teacher encourages and supports higher-order thought processes (Savery, 2006).	The teacher encourages us to present our ideas (opinions) and respects them. (DITS)
5.	Student autonomy and greater engagement in the learning process are encouraged, as well as active application of knowledge outside the school (Assor et al., 2002; Jang et al., 2010). It is necessary to animate students to search for information that can be applied in solving life situations; expand the learning process beyond the class, the classroom and the school itself (Yager, 1991, according to Jukić, 2013) Student participation in the research process allows them to feel that they belong to a learning community, and that they have something valuable to offer in that community (Rudduck & Flatter, 2004).	When a teacher assigns us a task or a problem, I see the benefit in everyday life (e.g., to protect our health, to preserve the environment, etc.) (ACTS)
6.	Research-oriented learning is focused on the development of thinking skills, problem solving, development of skills for (laboratory) research work (McReary et al., 2006; Oliver-Hoyo & Allen, 2005) Students are much better influenced by teachers who often ask questions than by teachers who mainly teach (transfer knowledge) (Marriott, 2014).	The teacher teaches and explains the teaching material in an interesting way. (ACTS)
7.	The teacher encourages and supports higher order thinking processes (Savery, 2006) Teachers need to learn how to ask essential questions to their students in order to encourage them to critical thinking and innovation (Wilhelm, 2014)	The teacher rarely encourages us to think about what we learn. (-) (ASTS)
8.	In research learning, it is important to synthesize the collected information, connect concepts, set hypotheses and possible explanations (Hmelo et al., 2006).	The teacher encourages the connection of key concepts into a meaningful whole. (ASTS)
9.	Continuous monitoring and evaluation of learning effects (Sawada et al., 2002).	The teacher evaluates our effort and work (not only at the end of the quarter / semester / school year) (DITS)
10.	The teacher encourages and supports higher order thinking processes (Savery, 2006)	The teacher's teaching dominates in biology teaching. (-) (ASTS)
11.	Learning has the nature of a research activity, through discovery and detection (Duschl & Grandy, 2013). Students participating in the research should be guided and directed to find the answers themselves through their own active engagement and acquisition of new experiences. (Ireland et al., 2012)	The teacher encourages the research of students in the text, on the model, graphs, microscopes, dissection, observation, etc. (COTS)
12.	Teamwork and work in small groups, with cooperation, is optimal (Keselman & Kuhn, 2002).	In biology classes, we often work in small groups, in pairs or on a joint problem-solving. (ACTS)
13.	Developing and presenting solutions and explanations by students (Hmelo-Silver et al., 2006)	The teacher encourages us to present the results of our work visually as well: on graphs, tables, slides. (COTS)
14.	Teachers provide different degrees of guidance during student research (Banchi & Bell, 2008) H Teachers provide more than one instruction in order to optimize learning outcomes (Ku et al., 2014). Guided research has a number of advantages over open, non-guided research (Lazorden & Harmisen, 2016; Carolan et al., 2014; D'Angelo et al., 2014).	In biology classes, we often receive worksheets or instruction sheets from teachers and work orders (COTS)

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No.	Current key approaches to research-oriented learning identified by different researchers	Statements
15.	Teachers provide more than one instruction in order to optimize learning outcomes (Ku et al., 2014).	The teacher connects what we learn in biology classes with the teaching material of other subjects (e.g., Chemistry, Geography, Physics, etc.) (DITS)
16.	Application of different sources of knowledge, creating challenging situations in the learning process (Colburn, 2006). The teacher applies more than one source of knowledge that students can use in the learning process (Brooks & Brooks, 1999)	The teacher encourages us to use different sources of knowledge: books, textbooks, the Internet, etc. (DITS)
17.	Modern technologies should be incorporated into the process of optimizing research-oriented learning (Buckner & Kim, 2014; Edelson et al., 1999).	The teacher in the biology class uses not only the textbook, but also the computer, presentations, video clips, brings models, etc. (COTS)
18.	Monitoring and evaluating the effects of learning is a continuous process (Sawada et al., 2002)	In biology teaching, we often evaluate the results of our work on our own. (ASTS)
19.	Teachers provide different degrees of guidance during student research (Banchi & Bell, 2008)	The teacher encourages us to ask questions ourselves and anticipate solutions to the problems. (ASTS)
20.	Teachers encourage students' independent research activity (Spronken-Smith & Walker, 2010) In teaching, do not separate the cognitive process from the research process (Brooks & Brooks, 1999)	In biology class, we perform experiments, tests, simulations, etc. (COTS)
21.	The teacher asks research questions and problems to which there is often no single answer (Lee et al., 2004)	The teacher encourages us to observe problems in the teaching material from different angles. (DITS)
22.	Monitoring and evaluation of learning effects (Sawada et al., 2002) Feedback as a powerful motivational tool influences the student achievement (Hattie & Timperley, 2007; Vallerand et al., 2008)	The teacher regularly informs us whether we have done something well or not. (DITS)
23.	Inductive reasoning method is often used in research learning (Colburn, 2006)	During the presentation of the teaching material, the biology teacher first presents the definition and then explains it through examples (-) (COTS)
24.	Teamwork and work in small groups with cooperation, is optimal (Keselman & Kuhn, 2002).	The biology teacher does not organize group work. (-) (DITS)
25.	During the research, students discover the answers themselves through their own active engagement and acquisition of new experiences (Ireland et al., 2012; Herman & Miranda, 2010).	In biology teaching, learning from direct experience is often represented (practical work, field work, observation). (ACTS)
26.	Individualized approach to the teaching contents and specification of one's own ideas (Harlen & Allende, 2009). Students participating in the research should be able to find the answers themselves through their own active engagement and acquisition of new experiences (Ireland et al., 2012).	The teacher enables each student to work independently and learn at his own pace. (ASTS)
27.	Setting problems that students need to solve by considering different ideas and theories (Keselman & Kuhn, 2002)	The teacher does not insist on the practical use of ideas and theories. (-) (COTS)
28.	Setting problems that students need to solve by considering different ideas and theories (Keselman & Kuhn, 2002).	The teacher poses problems for which a solution is reached by considering different ideas. (DITS)

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No.	Current key approaches to research-oriented learning identified by different researchers	Statements
29.	During the research, students discover the answers themselves through their own active engagement and acquisition of new experiences (Ireland et al., 2012; Herman & Miranda, 2010).	The teacher explains the teaching material with real-life examples. (ACTS)
30.	The teacher asks research questions and problems to which there is often no single answer (Lee et al., 2004)	The teacher poses problems that have a unique and logical solution. (-) (COTS)
31.	Teachers provide different degrees of guidance during student's research (Banchi & Bell, 2008).	The teacher does not criticize me when I make a mistake because of my haste. (ACTS)
32.	Inductive reasoning method is often used in research learning (Colburn, 2006)	The teacher first gives examples and then explains the given concept. (ASTS)

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