



PLOVDIV UNIVERSITY "PAISHII HILEENDARSKI"
FACULTY OF BIOLOGY
DEPARTMENT OF BOTANY AND TEACHING METHODS IN
BIOLOGY

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DEBATE AS A METHOD OF TEACHING BIOLOGY
IN SECONDARY SCHOOLS

ABSTRACT

for the awarding of the educational and scientific degree "Doctor"

Field of higher education: 1. *Pedagogical sciences*

Professional field: 1.3. *Pedagogy of teaching ...*

Doctoral program: *Methodology of teaching biology*

Scientific adviser: Assoc. Prof. Dr. Delka Karagiozova-Dilkova

Plovdiv, 2022

The thesis has been discussed and directed to defense at the Department Council of the Department of Botany and Teaching Methods in Biology at Plovdiv University "Paisii Hilendarski" (Minutes № 154/ 19.05.2022).

The thesis consists of an introduction, three chapters, a conclusion and appendices. 50 figures, 116 tables, 1 diagram and 3 appendices are included. The volume of the thesis is 286 pages. 130 sources are cited, of which 108 in Cyrillic and 22 in Latin.

The materials on the defense are available to those interested in the Department of Academic Staff and Doctoral Students Development at Plovdiv University "Paisii Hilendarski" and in the Central Library of Plovdiv University "Paisii Hilendarski".

The public defense of the thesis will take place on September 29, 2022 from hours at the Faculty of Biology, University of Plovdiv, 1 Todor Samodumov Str. with a scientific jury composed of:

1. Prof. Galya Kozhuharova, Ph.D.
2. Prof. Bianka Torniyova, Ph.D.
3. Prof. Dr. Rumen Stamatov, Ph.D.
4. Assoc. Prof. Dr. Margarita Panayotova
5. Assoc. Prof. Elena Karashtranova, Ph.D.

INTRODUCTION

The dynamically changing living conditions, the technical progress of society, the fast pace of economic development and the soaring criteria for successful social realization, definitely require changes in education, corresponding to the modern educational tendencies (Draganov, 2013).

Efforts are focused on creating a new interactive educational model, which is realized through interplay and dialogue between the parties in the learning process (Krasteva, 2010).

Interactive learning is based on the interrelation of the students with the learning environment, which serves as an area in which experience is gained. The aim is for students to turn from passive recipients of other people's knowledge into active constructors and moderators of their own and other people's knowledge (Panayotov, 2001).

Compared to traditional learning, interactive learning changes the interconnection between teacher and student: teacher activity gives way to student activity, its task is to create conditions for the development of their initiatives (Montessori, 1999). Teachers renounce their role of a kind of filter, omitting certain educational information, and act as assistants in the work and are one of the sources of information (Lavrentyeva, 2003).

Interactive methods mean constant feedback, constant engagement of the participant, helping to build a new educational reality based on joint search, dialogue, discussion and finding solutions (Gyurova, 2006).

One of the ways to meet these modern requirements is to organize training through debate.

The need for experimentally proven training through debate in biological education is extremely important because its implementation requires constant commitment of the participants, constant search for common solutions. The debate provokes more and better interactions between the trainer and the trainees, as well as among the students themselves. They support the personal development of the participants on the basis of empathy, interaction, dialogue, joint problem solving through analysis, search for alternatives and decision-making on a particular problem (Stoychev, 2007). Learning through debate provides an opportunity to jointly construct the subject of learning and pedagogical reality, so that everyone can take their share of responsibility for the learning process (Nikov, 2001).

CHAPTER I. THEORETICAL STATEMENT OF THE PROBLEM

Debate is fundamental and vital to democracy. Debate is not just a method of expression, but a form of persuasion. Debaters hope to change the other's opinion; they hope that their listeners will share their opinion. Debates do not lead to direct unanimity, but over time they can lead to consensus and an altered understanding of what is right and what is prudent. Debating is a game (Popper, 2012).

When analyzing the syllabi, we found that there is an opportunity to apply debates in the syllabi of 7th, 8th and 9th grade. The main goal of any debate is to convince a third, neutral party, called a judge, that one's arguments are better than those of the respective opponent. Although the goal is quite simple, the strategies and techniques for achieving it can be complex.

In Bulgaria there is no serious established experience in accepting the debate as a method of training. This is exactly what this research in the conditions of study in Bulgarian high schools requires.

I.1. Debate as an extracurricular form of education. Main elements of the debate

The pragmatic orientation of education towards European standards leads to the renewal of the training and qualification of teachers and the enrichment of their mental, personal and professional qualities.

The active participation of the student in the educational process is realized through analysis of real situations, guided discovery, interactive activities with the student placed at the center, thinking in the context of social interaction. (Gyurova, 2006).

For conducting any debate, these elements should be clarified:

The audience. The audience is central to debates and argumentation in all its forms.

Subject. There are different types of topics depending on the different forms of learning debate.

Affirmative party. During the training debate, the affirmative party must convince the judge that the topic is true; it defends the subject as formulated.

Negating party. Competitors on the negative side seek to prove to the judge that the statement made in the topic is incorrect.

Arguments. An argument can be a foundation, an argument or a proof. The best way to convince a judge that one's position is correct is through argumentation (Zigelmüller et al. 2009).

Evidence. The proof is the starting point of all arguments. It provides the building blocks for the basis of the argument and is therefore essential to any argument.

Facts. Facts include data that one has observed or become acquainted with in class, during daily learning, or in preparation for the debate. (Popova, 2015).

Statements and theses. Statements and theses are controversial assertions that the debater intends to support (or deny) using sound arguments.

Evaluation. After following the development of the whole debate and hearing the arguments of both parties, the judge will indicate their decision, noting on the form which team performed better in the dispute.

Responsibilities of the speaker. The success of the debate lies in group work or, rather, teamwork. As in any team, each member of the team plays a role and has responsibilities. Teams have 8 minutes each to consult (Popper, 2012).

CHAPTER II DESIGN AND METHODOLOGY OF PEDAGOGICAL RESEARCH

II.1. Nature of the researched problem

There is a contradiction between:

- the need to apply the interactive debate method in biology education to 7th, 8th and 9th grade students in high school, which would contribute to increasing the ability of students to formulate and ask questions, to express their thoughts clearly, effectively and convincingly, to refute ideas through well-thought-out arguments, to work in a team, to defend a position through concrete arguments, to respect the other one's point of view, by interpreting to the level of a specific variable educational technology, and

- insufficient motivation of students, who find the learning environment unpleasant, define the learning content as irrelevant, feel very busy and feel that there is no connection between teacher and student.

This contradiction has led us to determine the purpose, object and subject of pedagogical research.

II.2. Object of research

The object of research is the process of learning through debates of 14-16-year-old students in the study of the content of Biology and Health Education in 7th, 8th and 9th grade.

II.3. Subject of the research

The subject of the research is the acquisition of key competencies and increasing the motivation of students, achieved as a result of applying a methodological model of learning through educational debates in summary lessons in Biology and Health Education in 7th, 8th and 9th grade.

II.4. Purpose of the study

The present research aims to develop a theoretically sound, effective methodology for conducting educational debates and its experimental verification in summary lessons in Biology and Health Education in 7th, 8th and 9th grade.

Based on the goal, we formulated the following working hypothesis:

II.5. Working hypothesis

We assume that if a method of teaching - debate is applied in the teaching of Biology and Health Education, the motivation of students to learn will increase, so that they can master key competencies in the field of natural sciences, acquire learning skills and skills to support sustainable development and a healthy lifestyle.

To implement the purpose of the research and test the working hypothesis, we set ourselves the following tasks:

II.6. Research tasks

1. Research, analysis and generalization of scientific literature on the nature, traditions, contemporary experience at home and abroad in the application of debate, as a method of teaching and as an interactive form of learning.
2. Development of a specific interactive didactic model for the formation of key competencies in the field of natural sciences, learning skills and skills to support sustainable development and a healthy lifestyle and experimental verification of its effectiveness.
3. Development of criteria, indicators and tools for reporting the results of the experiment and testing the hypothesis.
4. Conducting the pedagogical experiment in 7th, 8th, 9th grade in four schools in the country in order to test the didactic model.
5. Summary of the obtained empirical data.
6. Mathematical and statistical data processing.
7. Statistical analysis of the obtained results and formulation of the respective conclusions.

II.7. Methodology and research methods

A set of interrelated research methods is used to solve the set tasks and test the hypothesis.

II.7.1. Methods of theoretical research:

Theoretical and methodological analysis, analysis of philosophical, psychological and pedagogical, sociological and scientific and methodological literature, Internet sources related to the subject of research; conceptual modeling.

II.7.2. Methods of empirical research:

- Transforming pedagogical experiment.
- Survey of students in connection with the study of motives, interests, attitudes and communication.
- Didactic testing to establish the acquired key competencies in the field of biology, learning skills, skills to support sustainable development and a healthy lifestyle.
- Mathematical and statistical methods, analysis and interpretation of the results.

II.8. Stages of pedagogical research

The pedagogical research was conducted over two school years in several stages:

II.8.1. Preparatory stage

- theoretical study of the problem;
- development of didactic materials for the experiment and tools for its reporting.

The concept for conducting the pedagogical experiment was developed on the grounds of the theoretical analysis, as were formulated the topic, the goal, the tasks and the hypothesis of the research. The model of the experiment was also developed; methodical development of experimental topics; instructions to the teachers conducting the experiment; didactic materials for the preparation of the debates; criteria, indicators and tools for reporting the results (questionnaires and didactic tests).

II.8.2. Conducting a transformative didactic experiment

The didactic experiment was conducted in two consecutive school years 2014/2015 and 2015/2016 among 685 students from 7th, 8th and 9th grade in the following schools:

- "St. St. Cyril and Methodius" High School - Plovdiv
- "Nikola J. Vaptsarov" High School - Tsarevo
- "Vasil Levski" High School - Malko Tarnovo
- "Nikola J. Vaptsarov" High School - Primorsko

All requirements for the correct conduct of a pedagogical experiment have been met.

II.8.3. Analysis of the obtained results

The results of the survey and didactic tests are presented in tables and figures, processed by statistical methods. For processing the obtained qualitative and quantitative results the SPSS program was used: alpha Cronbach's, T-test, Kolmogorov-Smirnov test, Correlation analysis, Friedman test. Tabular interpretations of the data from the pedagogical experiment on statistical reliability were made and on the basis of analysis the respective conclusions were made.

II.9. Description of the experimented methodological model

For there to be a dispute, there must be something to argue about. In the learning debate, this thing is a specific statement that is written as a topic. The teacher chooses the topic, formulates the goals of the debate and develops the didactic materials. After setting the topic, the teams and the jury are formed. A certain structure is followed during the learning debate. This means that each participant has the chance to speak, ask questions and build their own arguments. The arguments "For" and "Against" are based on the model of Toulmin, and the debate itself follows the optimized scheme of Karl Popper (2012). An argument is a foundation, argument or proof. The best way to convince a judge that a position is correct is through argumentation. Evidence may include facts that debaters have learned in classes on various subjects or in preparation for debates. The debater begins with selected evidence and then uses a substantiation process to relate it to the claim. In this way, the debater tries to convince the audience of the veracity of the statement to the same extent as they believe the evidence.

During the learning debate, the affirmative party must convince the judge that the topic is true, ie. it defends the subject as formulated. Competitors on the

negative side seek to prove to the judge that the statement made in the topic is incorrect.

In almost all learning debates, each participant answers questions from the opposite side to clarify a position or to correct an error in the opponent's statement, which results in cross-examination. The teams have 4 minutes for consultations.

After the presentation of the arguments of both teams, the teacher indicates which team was better in the dispute.

The methodological model for conducting a training debate is presented in Diagram 1.

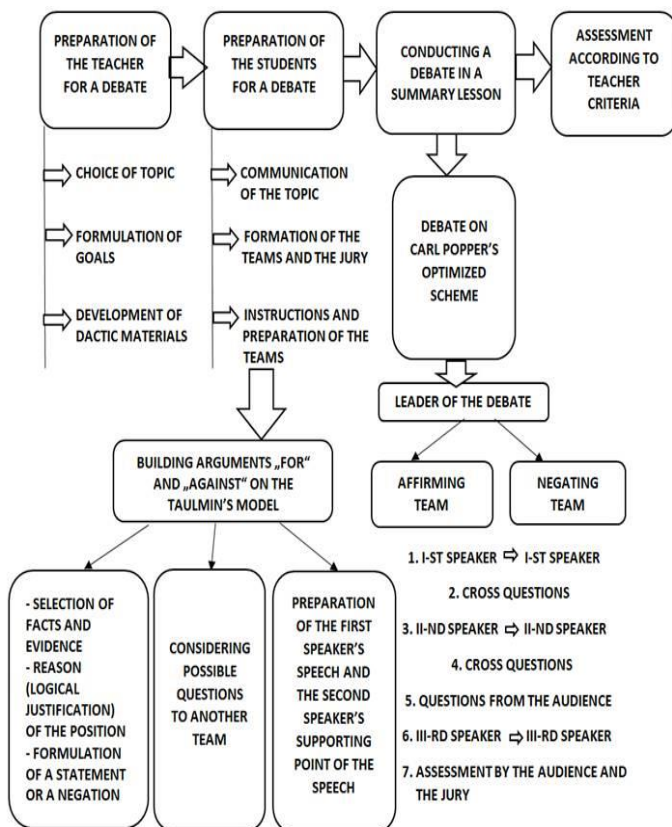


Diagram 1. Methodical model for conducting a learning debate

The experimental methodology with the inclusion of debate in summary lessons was conducted on the following topics:

Debate in 7th grade - Animal Kingdom section

1. Topic of the debate: "Animal experiments are justified."
2. Topic of the debate: "Cloning of humans and animals is necessary"

Debate in 8th grade - section "Health knowledge and hygiene"

1. Topic of the debate: "Alcohol is more useful than harmful."
2. Topic of the debate: "Vegetarianism is a healthy lifestyle."

Debate in 9th grade - section "Biotic and abiotic factors"

1. Topic of the debate: "Man can save the earth from ecological catastrophe."
2. Topic of the debate: "Shale gas production in Bulgaria - an opportunity or threat to the environment."

II.10. Criteria, indicators and tools for reporting the results

For the fulfillment of the set goals, tasks and hypothesis testing we selected the following criteria, indicators and developed a toolkit for reporting the results (Table 1).

A questionnaire with 13 questions was developed, examining the opinion of students from four schools in the country, after conducting biology lessons through the experimental model for educational debate. The questions in the questionnaire have an optional answer from three possibilities.

We developed and conducted didactic tests to account for the degree of increase in students' competencies as a result of the application of the experimental model with educational debates.

Table 1. Criteria, indicators and tools for reporting the results

	Criteria and indicators	Toolkit
How do we change students' motivation	Interest	Questions 1, 2, 3 from the questionnaire
	Relationship	Questions 7, 8, 9 from the questionnaire
	Communicativeness	Questions 4, 5, 6, 9, 10, 11 from the questionnaire
Development of key competences	Key competences in the field of natural sciences:	Tests for 8th grade for cognitive skills, for knowledge, understanding and

	Criteria and indicators	Toolkit
	-Names, describes rules for healthy eating and health prevention.	analysis of Bloom's taxonomy
	<p>Learning skills:</p> <p>-Discusses modern achievements in the field of biology.</p>	<p>Tests for 7th, 8th and 9th grade</p> <p>cognitive skills, knowledge, understanding and analysis of Bloom's taxonomy</p>
	<p>Skills to support sustainable development and a healthy lifestyle:</p> <p>- Argues the role of health prevention and health for the functioning of the body.</p> <p>- Predicts results of human impact on the environment and sustainable development.</p> <p>-Applies rules for Healthy lifestyle.</p> <p>-Evaluates and supports activities aimed at supporting sustainable development.</p> <p>-Describes and analyzes side effects of water pollution.</p>	<p>Tests for 8th and 9th grade</p> <p>cognitive skills, knowledge, understanding and analysis of Bloom's taxonomy</p>

CHAPTER III PRESENTATION AND ANALYSIS OF THE RESULTS

III.1. Presentation and analysis of the results of the survey

III.1.1. Distribution of students by classes

132 students participated in the first study from 7th grade; from 8th grade - 143 and from 9th grade - 112 students. The second study involved: from 7th grade - 113 students, from 8th grade - 111 and from 9th grade - 74 students (Fig. 1).

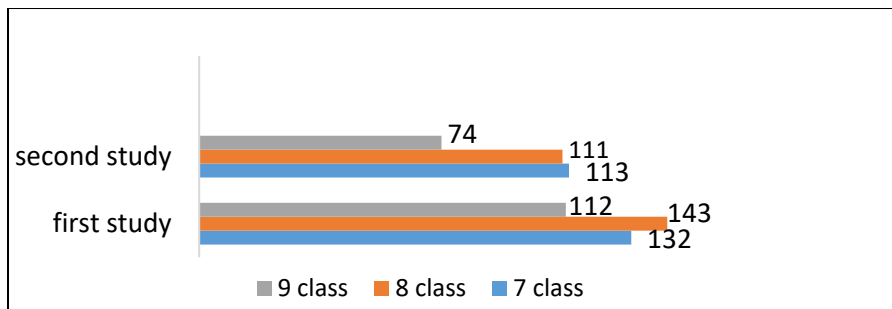


Fig.1. Distribution of students by classes

III.1.2. Distributed to students by schools.

In the first survey, the largest number of students (114 or 29.50%) were surveyed by "St. St. Cyril and Methodius" High School. From "Nikola Vaptsarov" - High School Tsarevo the number of surveyed students is 108 or 27.90%, followed by the students in "Nikola Vaptsarov" - High School Primorsko - 84 students or 21.70% and "Vasil Levski" High School - Malko Tarnovo - 81 or 20.90%.

In the second survey, the largest number of students 109 or 37% were surveyed by "St. St. Cyril and Methodius" High School; from "Nikola Vaptsarov" High School - Tsarevo - are 102 or 34%; in "Nikola Vaptsarov" High School - Primorsko there are 87 students or 29%; from Nikola Vaptsarov High School - Primorsko, respectively 84 or 29% (Fig. 2)

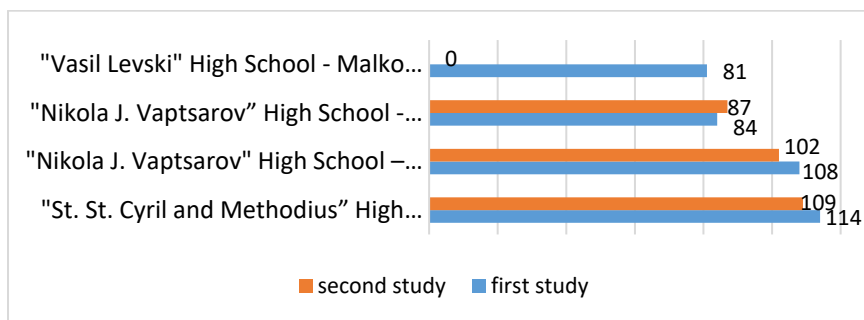


Fig. 2. Distribution of students by schools

III.2. Results of the survey

A questionnaire with 13 questions was developed, presented in Fig. 3 and in Appendix 1 of the PhD thesis. It explores the opinion of students after conducting biology lessons through the interactive method - debate. The questions in the questionnaire have an optional answer from three options (Yes, No and Partly).

Comparing the results of the survey conducted in the first and second survey, we find that in the second survey of questions 1, 2, 3, 7 to 11, all students answered positively.

Conducting a debate in biology was of interest to all students. They have learned what a debate is, how it is conducted and have improved their ability to search and process information. According to the survey data, in 98.7% the debate contributed to the increase of students' ability to express their thoughts clearly and convincingly, helped them to think creatively and critically, increased their ability to work in a team and listen, as well as the ability to speak in front of an audience and formulate questions (Fig. 3).

We have found that the percentage of students (99%) has increased on question 5 compared to the first survey, who believe that the debate has increased their ability to defend their position with concrete arguments and decreased the percentage of students (1 %) who are of the opinion that their ability to defend their position has partially increased.

The results of the answers to question 6 show that the percentage of students who believe that they have increased their ability to refute ideas through thoughtful arguments, compared to the first study increased to 98% and decreased the percentage of students - up to 2 % who believe that this has happened in part.

The answers to the 12th question on whether the debate helped to get to know their classmates show that the percentage of students (compared to the first survey) increased to 98.3% and the percentage of students decreased to 2.7%, who feel that they have partially got to know their classmates. None of the students gave a negative answer, unlike the first study, where the percentage of negative answers to this question was 15.2%.

Analyzing the answers to question 13, we have found that the second survey increased the percentage of students who answered that the debate taught them to respect the other point of view - 99.3%, decreased the percentage of those who believe that this has happened in part - 0.3%. None of the students gave a negative answer, unlike the first study, where the percentage of this question is 1%.

The results of the surveys clearly show that debate as an interactive form of the biology class is preferred by students because it develops skills for differentiated and creative thinking, improves speech skills in front of an audience, contributes to respecting different points of view and helps to get to know classmates.

There is a statistically significant difference between the first and the second study on the question "Do you think that in preparing the debate you increased your ability to express your thoughts clearly, effectively and convincingly?" ($\chi^2=110,125$; $P<0,0001$) (Fig. 4).

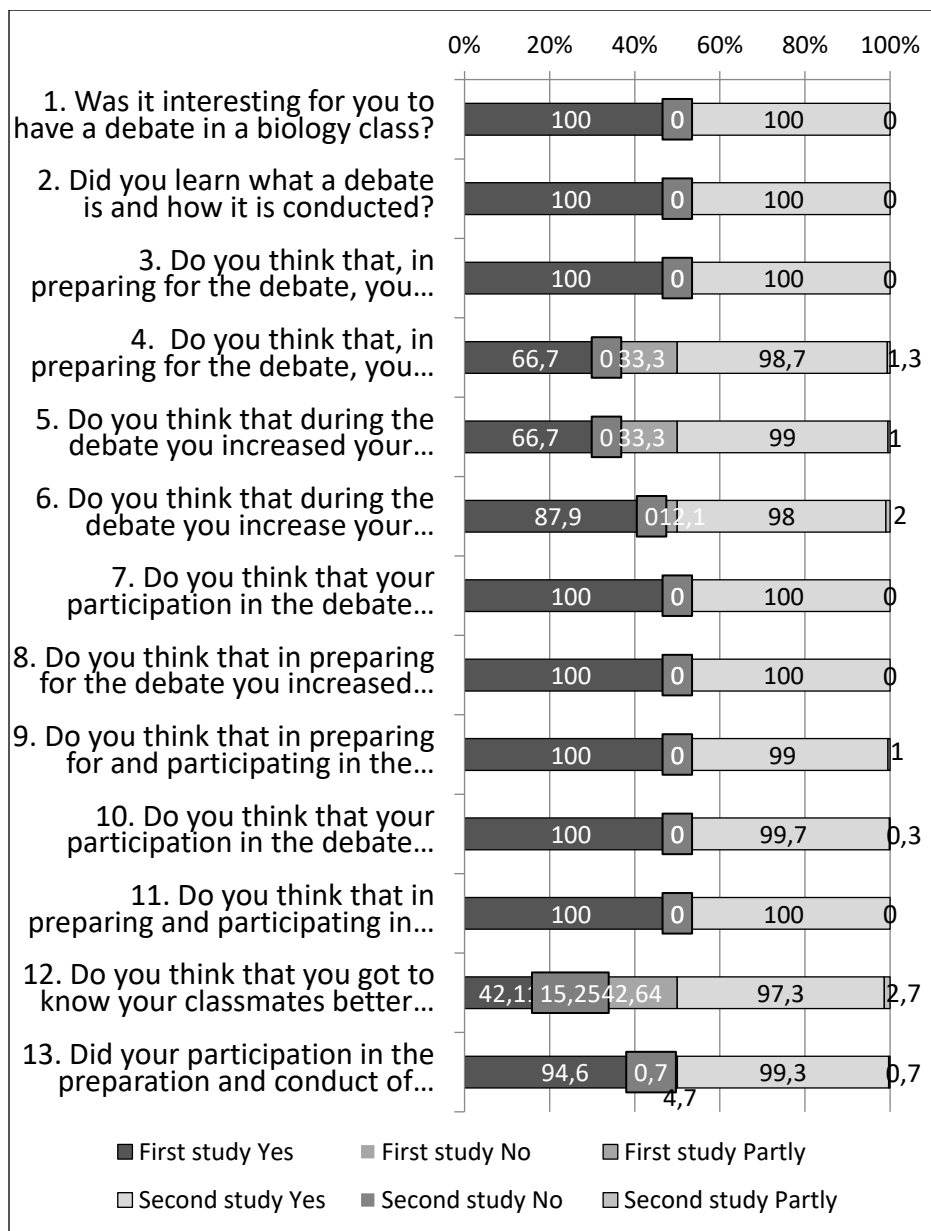


Fig. 3. Summary results of the survey

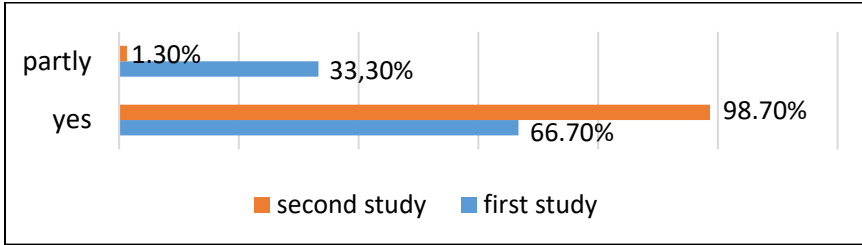


Fig. 4. Comparison of the first and second studies on the question: "Do you think that in preparing for the debate you have increased your ability to express your thoughts clearly, effectively and convincingly?"

There is a statistically significant difference between the first and the second survey on the question "Do you think that during the debate you increased your ability to defend a position with specific arguments?" ($\chi^2=113,094$; $P<0,0001$). In the second survey, only 1.0% of respondents said they "partly" felt that they had improved their ability to defend a position with concrete arguments during the debate, compared to 33.3% in the first survey (Fig. 5).

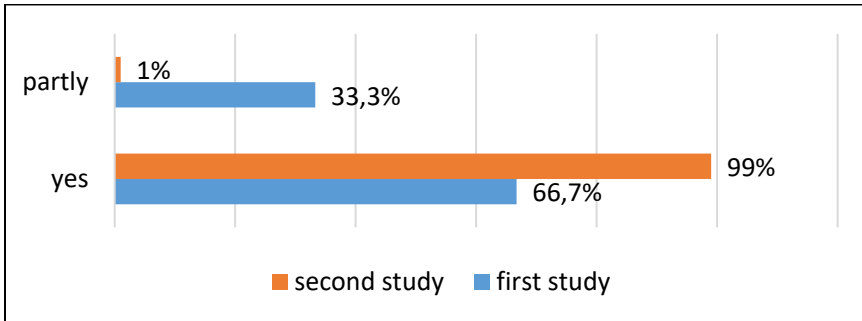


Fig. 5. Comparison of the first and second studies on the question "Do you think that during the debate you increased your ability to defend a position through concrete arguments?"

We find a statistically significant relationship between the first and second studies on the question "Do you think that during the debate you increased your ability to refute ideas through well-thought-out arguments?" ($\chi^2=113,094$;

P<0,0001). In the second survey, only 2.0% of students answered "partly", in contrast to the initial answers, which were 12.10% (Fig. 6).

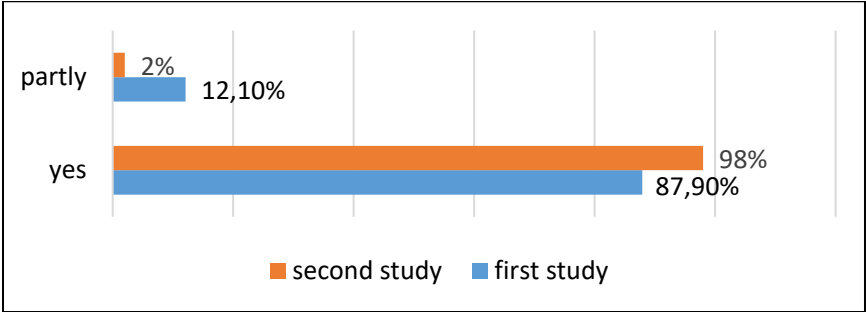


Fig. 6. Comparison of the first and second studies on the question "Do you think that during the debate you increase your ability to refute ideas through well-thought-out arguments?"

There was a statistically significant difference between the first and the second study on the question "Do you think that you got to know your classmates better during the preparation of the debate? ($\chi^2 = 229.394$; $P < 0.0001$). In the second survey, only 2.7% answered that it was "partly", unlike the first survey, in which 15.2% gave a negative answer and 42.6% of students answered "partially" (Fig. 7).

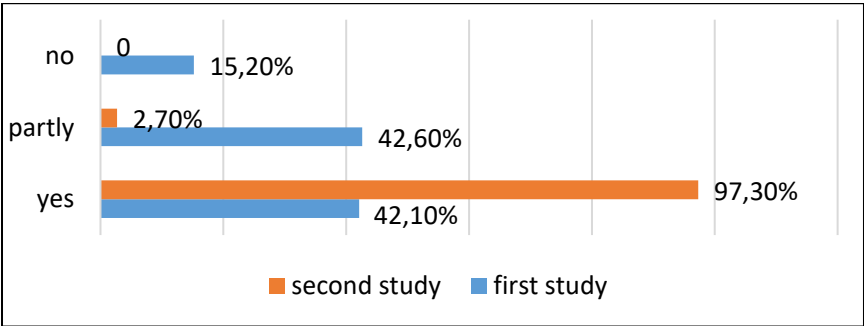


Fig. 7. Comparison of the first and second research on the question "Do you think that you got to know your classmates better during the preparation of the debate?"

We have found a statistically significant relationship between the first and second studies on the question "Did your participation in the preparation and conduct of the debate teach you to respect the other point of view?" ($\chi^2=11,838$; $P=0,003$ ($P<0,05$) (0.7% answered that this was true "partly", unlike the first survey (4.7%), and in the second survey there were no "No" answers to this question, unlike the first survey, where the percentage of the negative answers is 8% (Fig. 8).

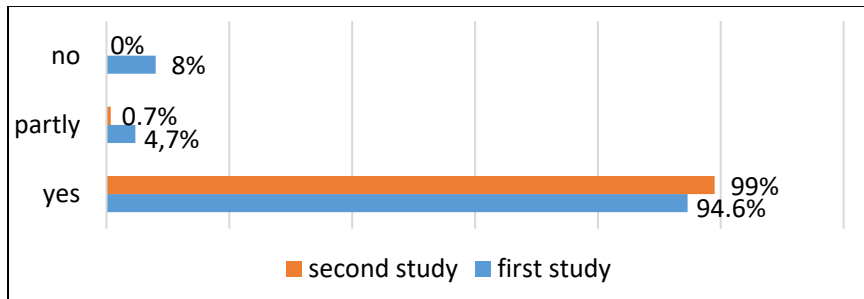


Fig. 8. *Comparison of the first and second research on the question "Did your participation in the preparation and conduct of the debate teach you to respect the other point of view?"*

The analysis of the results of the survey in the pedagogical experiment gives us reason to conclude that the inclusion of the interactive debate method in the teaching of biology and health education helps to raise the level of motivation for learning in students.

Our results are confirmed by the study of Setyadi et al. (2017), who by implementing the strategy of a team game tournament for active debate cooperation, increase interest in learning in the civic education process of students in 10th grade. (Setyadi et al. 2017). A study by Ansar et al. (2016) has also confirmed the results of our survey on improving students' ability to listen. From the analysis we can summarize that the inclusion of debate as a method in teaching biology definitely has a positive effect on the overall positive emotional attitude towards school and related objects.

Tracking the studied parameters in dynamics allows us to conclude that the greatest efficiency and stability of the results of the surveys is observed in improving students' communication and interpersonal relationships, as well as in improving their own intellectual abilities. This conclusion is confirmed by a study by Rido et al. (2020), in which the authors have found that as a result of

the application of the debate method, the ability to communicate and argue (reasoning) has been significantly improved (Rido et al., 2020). Another study by Ainun et al. (2019) examines the application of debate techniques in English language learning and the result has been improved communication and public speaking of students, as they develop one of the key competencies - communication skills in a foreign language (Ainun et al. 2019). Nani and co-authors (2021) conducted a debate and found that efficiency and harmony in students' communication were established, respecting the principle of politeness in language. It has a relationship of mutual respect, as a result of which communication and interpersonal relationships are improved. This confirms the results of our survey (Nani et al., 2021).

III.3. Presentation and analysis of the results of the didactic tests

III.3.1. Distribution of students involved in the preparation of the debate

98 students (25%) participated in the preparation of the debate in the first study, and 289 students were audiences (75% of students). In the second study, 64 students (21%) participated in the preparation of the debate, and 234 (79%) represented the audience during the debate (Fig. 9).

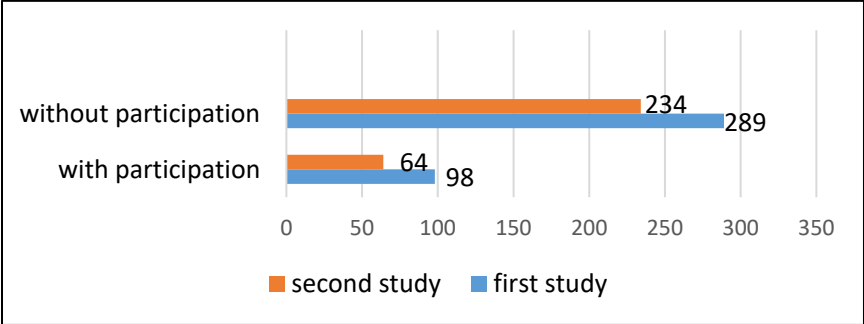


Fig. 9. *Distribution of students according to their participation in the debate*

III.3.2. Distribution of students by classes

The distribution of students in the tests by classes is as follows: in 7th grade - 133, in 8th grade - 144, in 9th grade - 110 students.

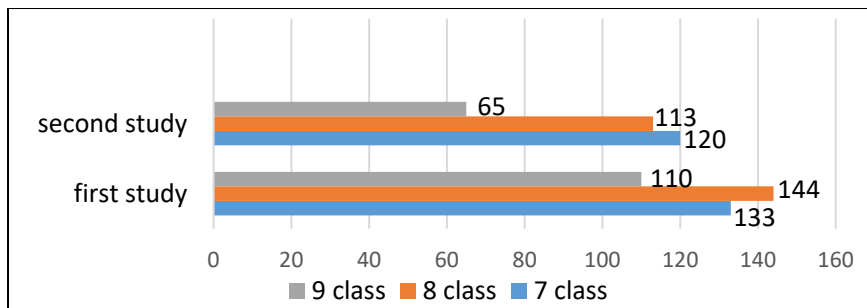


Fig. 10. *Distribution of students by classes*

Distribution of students in the tests by classes in the second study is: in 7th grade - 120 students, in 8th grade - 113 and in 9th grade - 65 students (Fig. 10).

III.3.3. Distribution of students by schools

Distribution of students by schools in the first and second surveys is shown in fig. 11.

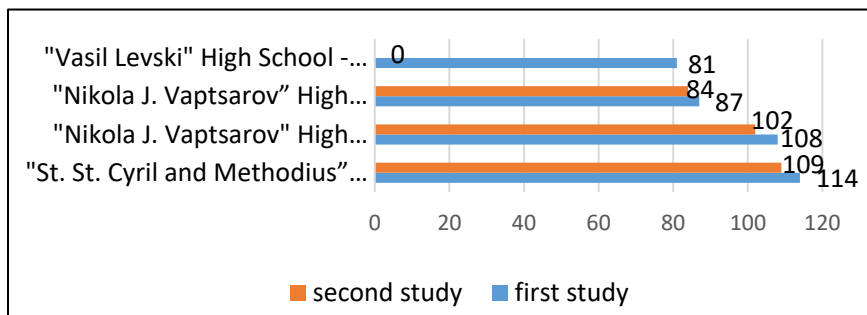


Fig. 11. *Distribution of students by schools*

III.3.4. Distribution of the average success of the test by schools

The analysis of the test results in the first study shows that the students from "Nikola. J. Vaptsarov" High School - Tsarevo (4.56), the lowest - the students from "V. Levski" High School - Malko Tarnovo (3.97) $P < 0.0001$ ($F = 5.37$), (Fig. 12). We associate this low result with the predominant number of students of Roma origin. The analysis of the results of the tests after the debate in the second study shows that the highest average score has students from "St. St. Cyril and Methodius" High School - Plovdiv (4.67), and the lowest average

result have students from “Nikola Vaptsarov” High School - Primorsko (4.34) $P < 0.0001$.

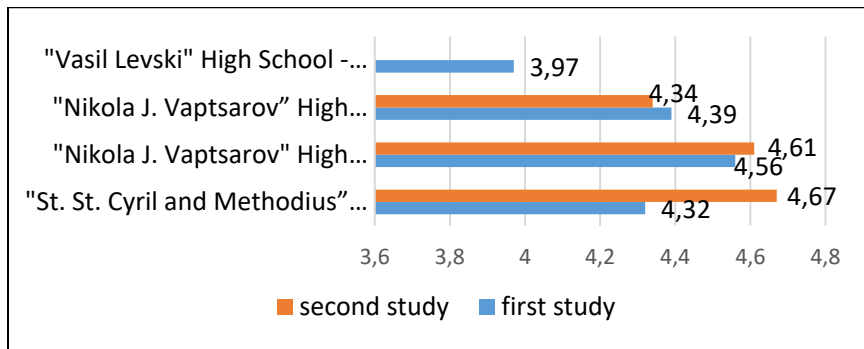


Fig.12. *Distribution of the average success of the tests by schools*

III.3.5. Distribution of the mean values of the students' grades during the debate

Analyzing the dependencies from the first study, we have found that students who prepared the debate were more successful than the tests (4.75) compared to students who were audience (4.19) in the debate, $P < 0.0001$ ($u = 4.46$)

Analyzing the dependencies of the second study by the Mann-Whitney method, we have found a statistically significant difference in the grades of students with participation and those without participation ($P < 0.0001$).

Without participation $N = 234$; $\bar{X} = 4.30 \pm 0.953$; $SEM = 0.062$

With the participation of $N = 64$; $\bar{X} = 5.36 \pm 0.698$; $SEM = 0.087$

Students who prepared the debate in the second study had a higher score on the tests (5.36) than students who were audience (4.30) at the time of the debate, $P < 0.0001$ (Fig. 13).

We attribute these results to the personality's focus on volitional learning. The student seeks connections and dependencies with what has been studied before, compares, evaluates and all this conveys new characteristics of what is memorized, strengthens its durability and opportunities for action (Löwe, 2005).

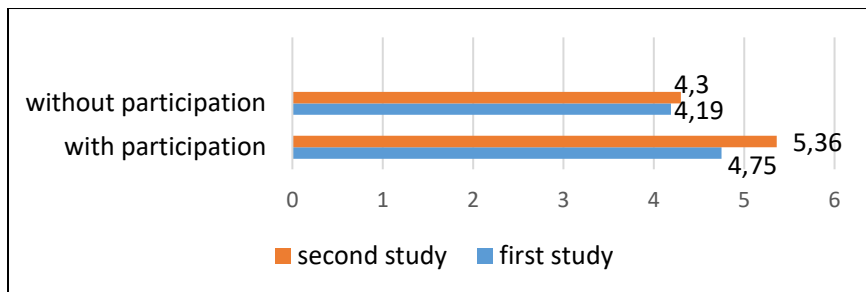


Fig. 13. *Distribution of the average success of the students from the audience and the participants in the debate.*

It is a matter of pedagogical mastery for teachers to contribute to the affirmation of the positive status of each student by appreciating not only their achievements in learning, but a number of personal qualities - openness, passion for other important activities. For students the need for independence grows. Adolescents want to make decisions, to show initiative. During the preparation of the debate, students form beliefs - internal positions, personal guidelines in behavior and activities. They are built the better, the more opportunities are given to students to express their opinions, to evaluate, to compare, to prove, to make decisions. Then they orient themselves more accurately in events and phenomena, more skillfully predict their development (Draganov, 2013).

III.3.6. Distribution of test results in girls and boys

The results of the first study show that girls have better test results (4.73), $P < 0.0001$ ($u = 8.66$) compared to boys (3.90). A second study also found a statistically significant difference in the mean scores of girls and boys using the Mann-Whitney method. It was 4.76 for girls and 4.26 for boys ($P < 0.0001$) (Fig. 14).

Girls	$N=162$; $\bar{x} = 4,76 \pm 0,911$; $SEM = 0,072$
Boys	$N=136$; $\bar{x} = 4,26 \pm 1,040$; $SEM = 0,089$

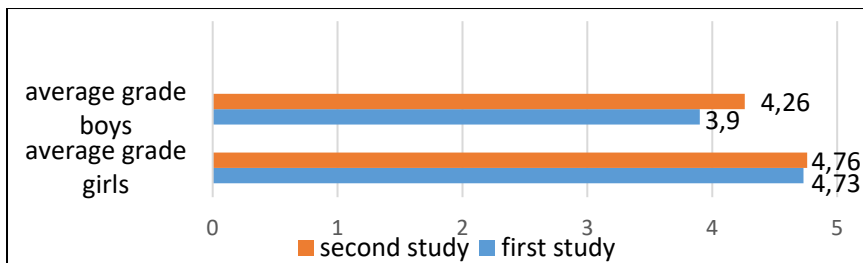


Fig.14. *Distribution of the mean values of the test scores for girls and boys*

The higher results in the girls in the two studies are attributed to the different motivation and orientation of the two sexes, which leads to a large extent to differences in their life goals. For women, priority is given to values that represent expressive, communicative and collective goals (Piryov, 2003). The androgenic personality combines effective strategies for both sexes and expresses a more complex style of behavior - it can be both ambitious and achievement-oriented / masculine stereotype /, but at the same time emotionally sensitive and responsive / feminine style / (Sapundzhieva, 2005).

III.3.7. Distribution of the mean values of the test scores in the different classes in both studies.

Analyzing the average results of the tests in the first study, we find that the highest score has students in 7th grade (4.86). $P < 0.0001$ ($F = 48.15$), followed by 8th grade students (4.34) and the weakest results in 9th grade (3.70). In the analysis of the average results of the tests in the second study, we find a statistically significant difference in the achievements of students from different grades ($P = 0.003$) by the method of the Kruskal-Wallis method.

The highest average result is again the students from 7th grade (4.74), followed by the students from 8th grade (4.47) and 9th grade (4.25), (Fig. 15).

The higher results of the seventh-graders in both studies are attributed to the fact that their interests in education become leading due to their upcoming application to other educational institutions. This increases their activity in the subjects, deepens their self-preparation, strengthens their desire to express themselves.

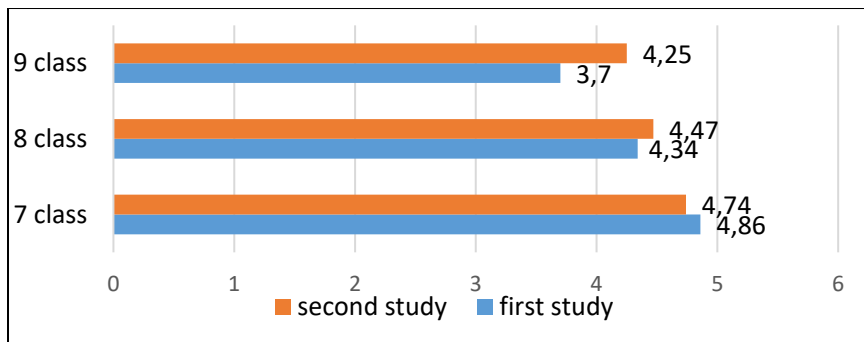


Fig. 15. *Comparison of the mean values of the grades from the tests in the different classes in the two studies*

These results may also be related to the influence of age dynamics. Age, as well as gender models and standards are determined by a number of biological, mental, socio-cultural and historical factors that affect the content of the development of goals and deadlines for their implementation. (Trifonov, 2005). The richer needs and interests of the seventh-graders are manifested in the fact that they show a strong receptivity to one or another side of reality, progress quickly in getting to know them, mastering them and feel emotional satisfaction from the activity. There is an urgent need for affirmation in cognitive activity through creative problem solving, discovery of dependencies (Tsvetkov, 2009). Needs multiply and stimulate interests. Cognitive, socio-political, aesthetic, moral, technical, ecological, etc. interests occupy an important place. They are characterized by greater depth, interconnectedness and resilience, have an active, active nature (Vasileva, 2004).

It is noteworthy that in the second study, ninth-graders increased their success compared to the first study. We attribute this fact to the introduction of the interactive debate method in their training, but in general they are the least successful in both studies.

Ninth graders want to make decisions, to show initiative, to overcome difficulties. They do not accept the imposition of tasks and orders. The main feature is the will for autonomy. It is the reason why a person zealously defends his views and shows painful ambition. As the character is still in the process of being built and there is not enough sustainability, this affects the attitudes, experiences as well as the learning outcomes (Daskalov et al., 2003).

III.3.8. Comparison of the mean values of the grades from the tests from the first and second research

When comparing the grades from the didactic tests by the Pearson Chi-Square method for the study of nominal values, no statistically significant differences were found in the ratio of girls / boys in grades and schools in either the first or the second study. There is no statistically significant relationship between gender and participation or not in the respondents' debate, class and school. The variable "estimate" has no normal distribution ($P < 0.0001$) and was studied by non-parametric methods - the Mann-Whitney method. A comparison of the two studies revealed a statistically significant difference in the grades of the students from the first and second studies ($P = 0.013$) (Fig. 16).

First study $N = 387$; $\bar{X} = 4.33 \pm 1.019$; $SEM = 0.052$

Second study $N = 298$; $\bar{X} = 4.53 \pm 1.002$; $SEM = 0.058$

In the first study the students had a lower average grade - 4.33, but after the second debate the positive effect of its application on the acquisition of knowledge was confirmed, as the average values of the grades in the second study increased by 4.53.

The analysis of the results allows us to conclude that the application of the interactive method "Debate" is effective in teaching students and helps to expand and consolidate knowledge of the relevant learning material.

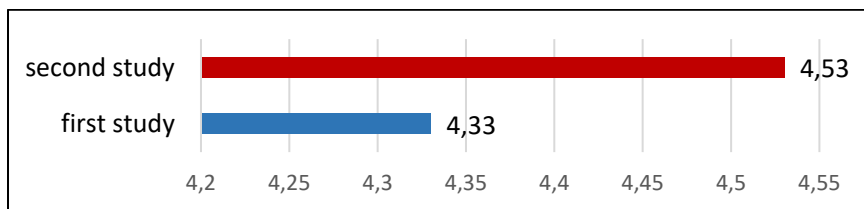


Fig. 16. Mean values of the grades of the students from the first and the second research

III.4. Conclusions from the conducted pedagogical experiment

The results of the pedagogical experiment and their analysis confirm the working hypothesis that the application of debate as a method of teaching increases students' motivation to learn and contributes to the formation of key competencies in the field of biology education.

1. The overall analysis of the obtained results shows that the experimented learning methodology is of interest to students and increases the motivation for learning activities. Debating is a fascinating way to learn, reinforce and apply learning content.
2. Debating on topics related to the learning content helps to improve the thought and cognitive processes, as well as to get to know classmates and respect other people's opinions. As a result of the debate, students have improved their communication skills.
3. The preparation and conduct of debates related to curriculum have increased the acquisition of core competences in the field of biological knowledge, competences related to learning skills and to support healthy lifestyles and sustainable development.
4. The developed methodological model for debate has proven its effectiveness in the teaching process in biology. This methodological model can be used in other curricula and help to improve the teaching of biology.

SCIENTIFIC CONTRIBUTIONS AND PRACTICAL SIGNIFICANCE

1. The methodology of teaching biology and health education in 7th, 8th and 9th grade of secondary school is enriched with a developed methodological model for applying debate in summary lessons, which forms communicative skills, science competence and competencies related to with skills to learn and support a healthy lifestyle and sustainable development.
2. An algorithm for constructing and conducting a debate in summary biology lessons in 7th, 8th and 9th grade is described.
3. A methodological model for summary lessons has been tested, with the application of debate as a method of teaching, which leads to a change in the attitudes of students to learning and the learning environment.
4. A diagnostic toolkit has been constructed to evaluate the results of debates in biology and health education.
5. The developed methodological model for the application of debate in summary lessons can be used in practice by teachers who teach biology and health education in 7th, 8th and 9th grade of high school.

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