REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

USE OF HISTORICAL MATERIALS ON THE CONTRIBUTIONS OF AZERBAIJANI SCIENTISTS TO THE DEVELOPMENT OF NATURAL SCIENCES IN THE MIDDLE AGES IN THE TEACHING OF PHYSICS IN GENERAL EDUCATION SCHOOLS

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GENERAL DESCRIPTION OF THE WORK

The actuality of the subject and degree of elaboration. The modern general education system in our country is evolving in accordance with the requirements of the "State Standards of General Education in the Republic of Azerbaijan".[1] These standards require pupils not only to master subject-specific programs but also to develop various educational and training skills. The competencies outlined in the State Standards of General Education framework document are classified into three categories, one of which is "values."

The value-based competencies intended to be developed in pupils across all subjects in the general secondary education level, including physics, focus primarily on fostering an understanding of national identity and a sense of national pride. In physics education, this value can be realized through the achievement of the following learning outcomes: The pupils understand their national identity and values their sense of national pride, meaning they:

- Develop patriotism and a senseof national pride.
- Respect the history, present, and homeland of the multi-ethnic Azerbaijani people.
- Recognize their Turkish affiliation.
- Interpret the history, language, and culture of their people and region, as well as the foundations of the scientific and cultural heritage of the Azerbaijani-Turkish peoples and humanity.
- Explain the history of science and its contemporary developments, particularly the role of the scientific heritage of Azerbaijani-Turkish philosophers and modern scientists in the advancement of world science and culture.
- Create and solve tasks related to the scientific heritage of Azerbaijani-Turkish thinkers, particularly their contributions to the creation and improvement of fundamental scientific theories, laws, and practical research tools.

[1] State Standards for General Education in the Republic of Azerbaijan." Collection of Legislation of the Republic of Azerbaijan, 2020, No. 9, Article 1233.

- Demonstrate a unified outlook that aligns with the modern level of scientific and social development taking into account the historical, social, cultural, and spiritual diversity of the world, as well as the history of language and science.
- Present the ability to embrace and master the humanistic, democratic, and traditional values of the multi-ethnic Azerbaijani society.
- Develop a sense of responsibility and duty to their motherland.

Currently, as in all subjects of general education, there is an intensive process of renewal and improvement in the teaching of physics. This process necessitates the development of more advanced subject content. The importance of fostering "a sense of national identity and national pride" among pupils has determined the components of this updated content. These components can be systematized according to the aforementioned learning outcomes as follows:

- Expanding the integration of the school physics course with other natural sciences;
- Providing factual information on elements of the history of science regarding the impact and role of the theoretical and practical scientific heritage of medieval Azerbaijani-Turkish and Arab naturalist philosophers, as well as modern scientists, on the development of natural sciences and technology;
- Including elements of the history of science that systematically present information about the life and contributions of medieval Azerbaijani-Turkish and Arab philosophers in the physics subject in secondary educational institutions to broaden pupils' scientific outlook and encourage them to correctly evaluate the significant role of natural sciences in society;
- Incorporating, alongside the history of science from Ancient Rome, the European Renaissance, and modern times, information on the scientific heritage of Azerbaijani philosophers, including the East (VIII-XVI centuries), into the physics subject to increase pupils' interest in the subject, develop their sense of patriotism, and improve the quality of the knowledge they acquire.

An analysis of various learning resources in physics (textbooks, methodological materials, evaluation tools, etc.), as well as discussions conducted with pupils, students, and teachers, revealed the following:

1.In the classic teaching resources for the "History of Physics" course included in the syllabus for training personnel in the "Physics Teaching" specialty, almost no information is provided about the theoretical and practical scientific research of Eastern philosophers during the Middle Ages. At best, only 1.5 or 2 pages of minor material are included.[2] According to these resources, it appears as if no research was conducted in mathematics, physics, chemistry, biology, astronomy, Earth sciences, medicine, or engineering sciences for 1,000 years, and the "Golden East" period, which significantly influenced the future of world science, did not exist.In the relevant textbook by Azerbaijani scientist V.I. Nasirov, the 5-page section under the subtitle "The Role of Eastern Scientists in the Development of Physics" very briefly mentions only Al-Khwarizmi, Al-Biruni, Al-Haytham, Ibn Sina, Al-Khazini, and some of the works of Bahmanyar al-Azerbaijani. In this direction, T.S. Vahidov, I.I. Vahabov, V.T. Vahidov, and I.I. Gasimov provide relatively extensive information in the training resources intended for bachelor's and master's level education in the "Physics Teaching" specialty.[3] As a result, future physics teachers are familiar with the inventions, discoveries, laws, and theories of English, French, Italian, German, American, and Russian scientists, engineers, and explorers from the XVIII-XX centuries. However, they have almost no systematic knowledge about Azerbaijani-Turkish engineers, philosophers, and inventors, including the medieval works of Eastern philosophers, even though these works, translated into Latin, were the main textbooks used in European universities and academies at that time.

[2] Əliyeva, N.A. Orta əsrlərdə Azərbaycan alimlərinin elmi əlaqələri və tədris fəaliyyəti / Əliyeva N.A. – Bakı: Turan NPB, 2015. – 168 s.

[3] Mario Gliozzi. History of Physics / Mario Gliozzi. – Moscow: Mir Publishers, 1970. – 464 p.

2.Pupils have almost no factual knowledge about the lives and works of medieval Azerbaijani-Turkish and Arab philosophers. Since relevant materials are not provided in the textbooks, students are unaware of:

- The developmental characteristics of physical knowledge during the Middle Ages and the Renaissance;
- Fundamental discoveries made by Azerbaijani-Turkish and Arab philosophers in mathematics, astronomy, optics, balances, densimeters, specific gravity, medicine, engineering, and mechanics;
- The fact that the methodological foundations of the development of science during the European Renaissance were based on the scientific activities of medieval Eastern philosophers.

As a result, pupils are unable to:

- Explain the role of medieval Eastern science in the formation of mathematics, physics, chemistry, biology, mechanics, astronomy, engineering, and medical sciences, starting from the European Renaissance;
- Provide examples of scientific research conducted in medieval scientific centers in Azerbaijan, Turkey, Baghdad, and Khorasan;
- Evaluate the role of the scientific heritage of medieval Azerbaijani philosophers in the development and establishment of the theoretical and practical foundations of physics, astronomy, optics, acoustics, mathematics, and mechanics in the history of natural sciences;
- Discuss the biographies of medieval Azerbaijani philosophers;
- Explain the fundamental concepts explored by medieval Eastern philosophers in the fields of physics, astronomy, mathematics, mechanics, optics, and acoustics;
- Appreciate, with a sense of national pride, the role of the theoretical and practical research conducted by Azerbaijani philosophers, including medieval Eastern thinkers, in shaping the natural scientific worldview of the world.

The object of the research is the process of determining the system of applied materials on the scientific heritage of Azerbaijani

philosophers, including medieval Eastern philosophers, to be used in the content of the physics course for classes VII-IX in general educational institutions

The subject of the research is the teaching methodology for utilizing systematized applied materials on the scientific heritage of Azerbaijani-Turkish philosophers, including medieval Eastern philosophers, at various stages of physics lessons for classes VII-IX in general educational institutions.

The purpose of the research is to determine the system of applied materials related to the scientific heritage of Azerbaijani philosophers, including medieval Eastern philosophers, to be used in the content of the physics course for classes VII-IX. The goal is to foster pupils' national identity and pride, stimulate intellectual interest in the subject, and expand their understanding of the unified natural scientific landscape of the world.

Tasks of research

1.To examine the reflection of the theoretical and practical scientific researches of Middle Ages Eastern philosophers in the main educational resources of the "History of Physics" course in the "Physics teaching" specialty in the universities before and after the independence of our republic.

2.To investigate the inclusion of applied content related to the scientific heritage of Azerbaijani philosophers, including medieval Eastern philosophers, in the physics textbooks, lesson plans, and methodological materials used in general educational institutions during those periods.

3.To analyze the possibilities of addressing this issue in dissertations, monographs, scientific-methodical resources, and articles.

4.To determine the principles and system for selecting applied materials on the scientific heritage of medieval Eastern philosophers, including Azerbaijani philosophers, to be used in the physics curriculum for classes VII-IX in general educational institutions.

5.To develop examples of the methodology for using applied teaching materials related to the scientific heritage of Azerbaijani

philosophers, including medieval Eastern philosophers, at various stages of physics lessons in classes VII-IX.

6.To preparate a special optional course program based on systematized appropriate teaching materials and a brief outline of its content.

7.To examine through a pedagogical experiment the impact of determining the system of applied materials related to the scientific heritage of Azerbaijani philosophers, including medieval Eastern philosophers, on the development of pupils' understanding of national identity, national pride, intellectual interest in the subject, and conceptions of the unified natural scientific landscape of the world in the physics education of classesVII-IX.

Main Provisions to be defended:

1.The system of educational materials, selected based on various didactic principles, for using applied information on the life and scientific heritage of Azerbaijani philosophers, including medieval Eastern philosophers, in the physics course for classes VII-IX in general educational institutions.

2.The content and teaching methodology for the applied educational materials regarding the life and scientific heritage of medieval Eastern philosophers, including Azerbaijani philosophers, proposed for use in the physics curriculum for classes VII-IX in general educational institutions.

3.The program and content of a special optional course aimed at expanding and enhancing the relevant knowledge and skills that pupils will gain on the investigated topic.

Scientific Novelty of the Study:

1.As one of the ways to develop pupils' understanding of national identity and national pride, as well as their cognitive interests in the subject and their perceptions of the unified natural scientific worldview, to determine the system of applied materials in classes VII-IX physics course in general education institutions about the life and creativity of Azerbaijani philosophers, including medieval Eastern philosophers, and to justify their use from a scientific-pedagogical point of view.

2.The determination of the system and content of applied instructional materials for the research problem from the perspective of the requirements of the State Standards of General Education and the relevant content standards of physics course for the classes VII-IX in general education institutions, including the development of examples of teaching methodology.

3.The development of a special optional course program and the identification of the system and content of appropriate teaching materials for the study of the contributions of Azerbaijani philosophers, including medieval Eastern philosophers, to the formation of mathematics, physics, and other natural sciences in world scientific history.

Theoretical and Practical Significance of the Study:

1.The use of a system of applied materials related to the life and scientific heritage of Azerbaijani philosophers, including medieval Eastern philosophers, enhances the educational potential of the content and teaching methodology of the physics course for classes VII-IX.

2.The teaching materials for the "History of Physics" course, intended for bachelor's degree programs in the "Physics Teaching" specialty at universities, can be enriched with content related to the history of science during the medieval period.

The system of applied materials identified for the physics course in classes VII-IX of general educational institutions, as well as the proposed special optional course on the subject, will support students in developing their sense of national identity. The proposed methodology for teaching physics helps foster cognitive and national pride competence, stimulates cognitive interest in the subject, and promotes a unified perspective on the natural scientific worldview. This methodology contributes to the development of the field of science education and provides practical assistance to physics teachers.

Methodological Basis of the Research: The methodological basis of the research is derived from:

- The "State Strategy for the Development of Education in the Republic of Azerbaijan," approved by the President of the Republic of Azerbaijan, Mr. Ilham Aliyev, on October 24, 2013;

- Congratulatory letters addresses by the President to participants of the XV and XVI Congresses of Azerbaijani Teachers;
- The "Law on the Right to Education" of the Republic of Azerbaijan;
- The "State Standards of General Education in the Republic of Azerbaijan";
- The physics curriculum for general education schools (grades VII-XI);
- Modern didactics and teaching technologies for general education;
- Studies reflecting the life and works of medieval Eastern philosophers.

Experimental Base of the Study: The experimental base of the study consisted of the following schools: Secondary School No.23, named after Tahir Hasanov, in Baku city; Secondary School No.276 in the Binagadi district; Secondary Schools No.1 and No.53 in the Fuzuli district.The pedagogical experiment was conducted between 2012 and 2023.

Approbation of the research. The main theoretical propositions of the dissertation were published in eleven works and presented for public discussion.

The name of the organization where the dissertation work was done. The dissertation was performed at the Department of Physics Teaching Technology, Faculty of Physics, Azerbaijan State Pedagogical University.

Structure and volume of the dissertation (in signs indicating the volume of each structural subdivision separately). The dissertation consists of an introduction, 3 chapters, conclusion, a list of used references. Total volume of the dissertation work – 216 329 characters (introduction – 15 891, chapter I – 81 635 chapter II - 82 904, chapter III – 32 878, conclusion – 3021).

THE MAIN CONTENT OF THE DISSERTATION

In the introduction, the relevance of the selected topic is justified, the object and subject of the research were specified, the

goals and tasks of the research were outlined, the research methods were defined, and its novelty, significance, and practical importance were discussed. The methodological basis of the research was also indicated, and the main propositions defended in the dissertation were formulated.

The first chapter of the dissertation, titled "The Place and Role of Medieval Eastern Science in the Historical Context and the Study of Its Current State in the Physics Curriculum at Different Educational Levels," examines the life and work of Azerbaijani philosophers, including Muslim Eastern philosophers, and analyzes their scientific heritage during three periods of the Middle Ages (Early Middle Ages – 8th to 12th centuries, High Middle Ages – 12th to 14th centuries, and Late Middle Ages – 14th to 17th centuries), with a focus on the formation of natural sciences, mathematics, medicine, and engineering. This chapter also discusses the research methods and tasks, which are based on the goals of the dissertation.

From the conducted research, the following conclusions can be made:

- The formation and development of the history of science during the 9th–16th centuries, particularly in the natural, mathematical, and humanities sciences, including mechanics, light and sound phenomena, astronomy, biology, medicine, mathematics, music, philology, and philosophy, were significantly influenced by classical research and discoveries made by Muslim Arab, Persian, Ottoman Turkish, and Azerbaijani philosophers.
- From the study of quotes taken from the works of medieval European historians, translated into Turkish and Russian, it was determined that, according to the historians of that era:

– The centers of development for all fields of science in the 9th to 16th centuries were in the Muslim East – in Baghdad, Maragheh, Istanbul, and Samarkand.

– The philosophers who created these scientific centers and conducted research with their newly invented instruments wrote their books in Persian and Arabic. These works were translated into Latin, French, and English and were used as textbooks for a long time in major academic cities such as Paris, Rome, London, Krakow, and

Madrid. With the help of the textbooks and tools created by Eastern philosophers, later European scholars and travelers – such as Tycho Brahe, Copernicus, Christopher Columbus, Galileo, Newton, Hooke, and others – developed new physical laws and made discoveries about new lands.

- Factorial materials reflecting the lives and contributions of medieval Arab, Persian, Turkish, and Azerbaijani philosophers were collected.
- The content of educational materials on the lives and works of Arab, Persian, Turkish, and Azerbaijani philosophers from the 9th–16th centuries, which could be incorporated into the "History of Physics" course within university curricula, was identified.

Regarding research in our country and neighboring countries, an analysis was conducted of the scientific-methodical works on the subject. The level of development of research in this area was examined. As a result of the analysis, it was found that the medieval period of the history of physics has not been adequately studied at the encyclopedic or dissertation level.

In the second chapter of the dissertation, titled "Methodology of using historical materials on the development of natural sciences of Azerbaijani in the Middle Ages, including the Eastern philosophers, in the teaching of physics in secondary schools" discusses the principles for selecting scientific and educational materials about the life and work of medieval Azerbaijani, Turkish, and Arab philosophers, their significant role in the formation of world science, and the application of this material in the teaching of physics. The methodology of using these materials at various stages of the physics lessons (interest arousal, research, information exchange and discussion, creative application, and evaluation stages) is also provided through examples. [4]

As a result of the research in the first sub-chapter of the second chapter, it was determined that it is appropriate to select applied

[4] Akhutin, A.V. History of the Principles of Physical Experiment from Antiquity to the 17th Century / A.V. Akhutin. – Moscow: Nauka, 1976. – 148 pages

materials on the scientific heritage of medieval Azerbaijani philosophers based on the following didactic principles:

- The scientific principle
- The principle of visuality
- The principle of relevance
- The principle of goal-orientation
- The principle of systematicity and consistency
- The principle of connection with the life
- The Principle of Consciousness and Activity (Engagement)
- The Principle of Educational and Developmental Purpose

In the second sub-chapter of the second chapter, it is noted that in the teaching of natural sciences, including physics, subject teachers usually refer to the history of science during the stage of raising interest in the lesson.[5]

At this stage, the main goal is to attract pupils' attention to the new educational material being studied. As a result, both some teachers and certain methodological recommendations often attempt to engage pupils by presenting stories and legends related to the history of physics to spark their interest in the subject. Examples of such narratives include: "The Legend of Newton and the Apple," "The Legend of Sisyphus and the weigh of the Stone," "The Legend of Prometheus and Fire," and "The Legend of Eureka."[6] Brief information about these legends is provided. The subsection also notes that including such intriguing information in the content of appropriate lessons can be useful for understanding certain physical concepts and regularities.

However, it is emphasized that these unscientific legends, when used unsystematically and sporadically, can have only a superficial and short-term impact on the study of physics, much like any sensational information.

To generate lasting interest in physical science and physics among pupils, it is necessary to reveal the dynamics and

[5] Robert Briffault (1928). The Making of Humanity. G. Allen and Unwin Ltd.

[6] Akhadova, M.A. The Arithmetic Part of ibn Sina's "Book of Knowledge". The Geometric Part of ibn Sina's "Book of Knowledge" / M.A. Akhadova // Scholarly Notes of the Bukhara State Pedagogical Institute. – 1964. – No. 12. – pp. 263–281.

developmental trends of physical ideas and concepts throughout the history of science. Pupils should be guided to understand the reasons behind the emergence of ideas about physical phenomena, theories, and laws, the sequence of the search mechanism for these causes, and the atmosphere of dedicated scientific work.

The methodology for using a system of materials, selected based on well-known didactic principles, related to the lives and works of medieval Azerbaijani philosophers in teaching physics at the general secondary education level, has been developed. To this end, some physics lesson models for grades VII-IX have been prepared.

Additionally, in this chapter, the program and content of a special faculty course in physics have been developed, focusing on the applied training materials for the research object.

The content of the course is as follows: The course consists of three sections. The first section covers the lives of Arab, Turkish, and Azerbaijani philosophers who lived in the 8th-9th centuries and their contributions to the development of natural sciences. The second section discusses the materials from the 10th-13th centuries, and the third section examines the scientific heritage of Turkish and Azerbaijani philosophers from the 14th-16th centuries. [7]

The learning outcomes of the course are defined as follows:

- Explains the role of Azerbaijani philosophers in the development of natural sciences, including physics, in the Middle Ages.
- Explains the contribution of medieval Azerbaijani philosophers to the understanding of various natural phenomena, including physical events and processes.
- Collects materials related to physical events and processes and applies them in the preparation of posters.
- Classifies the ideas of medieval Azerbaijani philosophers in the explanation of physical events and processes.

[7] Resulzade, M.Ə. Azerbaycan şairi Nizami, sekizyüzüncü yildönümü münasebetiyle, 1149-1941 / M.Ə.Resulzade. – Ankara: Milli Egitim Basimevi, 1951. – 402 s.

- Summarizes the ideas of medieval Azerbaijani philosophers in explaining physical phenomena and processes.
- Evaluates the role of medieval Azerbaijani philosophers in the development of natural sciences.

Chapter III, entitled "Pedagogical Experiment and Its Results," consists of two sub-chapters. It is mentioned here that the main purpose of the experiment is to check the validity of the research hypothesis. The purpose of the pedagogical experiment is to verify the correctness of the formed research hypothesis.

The hypothesis of the research is as follows: in the teaching of physics in grades VII-IX of general education institutions, it is possible to develop pupils' understanding of national identity and competence in national pride—specifically, their feeling of national patriotism and cognitive interest in the subject—when:[8]

1. A system of applied historical materials on the life and scientific heritage of Azerbaijani philosophers, including medieval Eastern philosophers, is used at various stages of physics education.

2.A special optional course program is developed to study the life and Azerbaijani philosophers, including works of medieval Eastern philosophers, in the formation of mathematics, physics, and other natural sciences in the history of world science. A system of appropriate training materials should be prepared, and the solution to the research problem should be completed.[9]

The base schools for the pedagogical experiment were selected as follows: Secondary School No. 23 named after Tahir Hasanov in Baku, Secondary School No. 276 in Binagadi district, and Secondary Schools No. 1 and No. 2 in Fuzuli district. When choosing these schools, the following criteria were considered:

- Availability of a material and technical base for conducting physical experiments.
- Physics classrooms equipped with multimedia and computers.

[8] Abdullayev B.A., Zülfüqarova Ş.V. Didaktikanın bəzi aktual problemləri. Bakı: ADPU-nun nəşri, 2006, 162 s.

[9] Закуев, А.К. Философские воззрения Бахманяра / А.К. Закуев. – Баку: Изв-во Акад.Наук Аз ССР, 1958. – 92

- High scientific-methodological professionalism of subject teachers, including their knowledge of modern active learning methods and their systematically use in lessons.
- Proximity of the schools to the researcher's direct control area.
- Presence of at least two classes from each of the VII-IX grades in order to conduct a comparative study between control and experimental classes.

A total of 583 pupils were involved in the pedagogical experiment, including 186 pupils in grade VII, 192 pupils in grade VIII, and 205 pupils in grade IX. During the experiment, systematic meetings and discussions were held with the physics teachers in the VII, VIII, and IX classes of those schools (and also with teachers in the VI classes from 2013-2018). These discussions focused on providing them with applied materials related to the research topic in the structure and content of the corresponding physics textbooks. Ideas were exchanged, and lessons were observed. Additionally, with the help of subject teachers, anonymous questionnaire surveys were conducted among the pupils of the relevant classes, and their diagnostic and formative evaluations on the research problem were carried out.

The pedagogical experiment was carried out in three stages: identifying, searching, and teaching. Each stage had its own specific goals and objectives.

Thus, at the determining stage of the experiment, the role of Muslim Eastern science of the Middle Ages in the development and formation of the history of science for pupils in grades VII-IX was studied. This included investigating the perceptions of the life and scientific heritage of Azerbaijani philosophers from that period, and how these perceptions influenced the development of pupils' sense of patriotism. To achieve this, diagnostic assessments of pupils in both control and experimental classes were conducted at five levels, based on three criteria related to the research problem.

For qualitative processing of the results, we assigned quantitative scores to the levels of formation of quality indicators: 0, 1, 2, 3, and 4. Each score corresponds to a specific level:

- 0 points – unacceptable level
- 1 point – critical level
- Level IV (optimal) – 3 points
- Level V (high) –4 points
- 2 points – acceptable level
- 3 points – optimal level
- 4 points – high level

Then, by calculating the average score, the level of formation of the studied quality was determined and quantitatively evaluated. The levels were classified as follows:

- Level I (unacceptable) – 0 points
- Level II (critical) – 1 point
- Level III (acceptable) – 2 points

The results obtained from tests, questionnaires, methods of completing incomplete sentences, conversations, analysis of pupils' activities, and observations were processed accordingly. As a result, the indicator of the pupils' level based on the selected quality criteria was quantitatively evaluated.

In the assessment, only the success indicators, i.e., the average value of the indicators ($M_{ave} = \frac{(m_3+m_4+m_5)}{n} \cdot 100\%$) for levels III-V, were determined (see tables 3.2).

Table 3.2
Success Indicators of pupils based on the First Quality Criterion

Schools	Classes		Number of pupils (n)	Assessment by levels					M_{ave} – Success rate, (in %)
				I (m_1)	II (m_2)	III (m_3)	IV (m_4)	V (m_5)	
Secondary school №23 named after Tahır Hasanov	E	$7a$	27	6	16	5	0	0	18,52
	N	$7b$	28	7	15	6	0	0	21,43
	E	$8a$	23	6	10	7	0	0	30,44
	N	$8b$	21	5	10	6	0	0	28,57
	E	$9a$	24	3	12	8	1	0	37,50

	N	9*b*	22	3	11	7	1	0	36,37
Secondary school No. 276, Binagadi district, Baku	E	7*a*	26	6	16	4	0	0	15,39
	N	7*b*	28	7	16	5	0	0	17,86
	E	8*a*	28	7	15	6	0	0	21,43
	N	8*b*	27	7	15	5	0	0	18,52
	E	9*a*	24	5	12	6	1	0	29,17
	N	9*b*	28	5	15	6	2	0	28,57
Secondary school No. 1 of Fuzuli district (Sabunchu district, Baku)	E	7*a*	17	5	8	4	0	0	23,53
	N	7*b*	16	5	7	4	0	0	25,00
	E	8*a*	16	5	6	5	0	0	31,25
	N	8*b*	16	4	7	5	0	0	31,25
	E	9*a*	18	3	8	6	1	0	38,89
	N	9*b*	21	4	10	6	1	0	33,33
Secondary school No. 2 of Fuzuli district (Binagadi district, Baku city)	E	7*a*	15	5	7	3	0	0	20,00
	N	7*b*	15	5	7	3	0	0	20,00
	E	8*a*	15	5	6	4	0	0	26,67
	N	8*b*	16	5	7	4	0	0	25,00
	E	9*a*	16	3	7	4	1	0	31,25
	N	9*b*	18	3	7	5	1	0	33,33

As can be seen from the analysis of the tables, the qualitative success indicators of the pupils in both the experimental and control classes on the selected criteria are very low. This means that they have almost no information about the proud life and work of Azerbaijani philosophers, including medieval Muslim Eastern science, which played an important role in the history of the formation of science, within the physics teaching resources. Conversations with subject teachers revealed that during their studies in higher education, pupils only received very brief information about the works of Al-Buruni and Ibn Sina from the medieval philosophers in the "History of Physics" course. This opinion of the teachers was confirmed during the analysis of those textbooks (see:

subsection-1.2). Therefore, we purposefully investigated the work arising from the research task. The research revealed that the structure and content of physics textbooks and teaching materials for teachers in classes VII-IX meet general pedagogical, psychological, and methodological requirements. However, in these resources, the competence-based value intended to be formed in pupils, particularly for the understanding of national identity and the education of the sense of national pride, is not adequately or completely represented through applied materials on the scientific heritage of Azerbaijani philosophers.

In the second stage of the pedagogical experiment, the subject interests of the pupils, as well as the quality of their knowledge and skills, were examined regarding the subjects studied in physics training in classes VII-IX. Based on the recommendation of researcher, subject teachers in classesVII-IX assessed the level of awareness of the pupils about the scientists and philosophers who contributed to the formation of fundamental physical concepts and laws through intra-subject and interdisciplinary integration. For this purpose, the influence of regularly using historical applied materials on the life and creativity of outstanding scientists in various lesson stages, particularly during the formation of new concepts and laws in physics education, was studied in relation to the cognitive interests of pupils and the quality of their knowledge. Generalizations were made as a result of the research. During this phase, attention was paid to the following points:

- The inclusion of historical materials on the scientific heritage of medieval Azerbaijani-Turkish philosophers in the description of the content of fundamental physical concepts and laws in physics textbooks, and the possibility of using them;
- The principles of selecting historical applied materials on the life and scientific heritage of Azerbaijani-Turkish philosophers, including medieval Muslim Eastern philosophers, in the teaching of physics in classes VII-IX in general educational institutions;
- The place and content of providing historical applied materials on the life and scientific heritage of medieval Muslim Eastern philosophers, including Azerbaijani-Turkish philosophers, in

the content of the physics course in classes VII-IX in general educational institutions;

- Pupils' perceptions of the role of the scientific heritage of Azerbaijani-Turkish philosophers, including medieval Muslim Eastern philosophers, in the history of world civilization, etc.

In the third stage of the pedagogical experiment, the following research methods were used:

1. Examining the learning outcomes of pupils according to the research problem through interviews.
2. Measuring the appropriate learning outcomes of pupils through closed and open test tasks.
3. Evaluating the knowledge and skills of pupils by analyzing them in parts.
4. General notes, personal opinions, and recommendations of physics teachers from experimental schools.
5. Drawing conclusions.

Results of the Pedagogical Experiment

The leading objective of the experiment was to provide historical materials related to the scientific heritage of medieval Azerbaijani-Turkish philosophers for inclusion physics course in the classes VII-IX. This aimed to enhance the content of the textbooks for these grades, refine the teaching methodology, and evaluate its influence on the qualitative development of pupils' cognitive interest and knowledge in physics.

For the experiment, students were divided into five groups based on their level of cognitive interest in physics. At each level, the intended learning outcomes of the physics subjects for classes VII-IX were taken as the basis.

The levels were assessed using a 50-point criterion:

- Zero level: 0–10 points;
- Low level: 10.1–20 points;
- Average level: 20.1–30 points;
- Above average level: 30.1–40 points;
- High level: 40.1–50 points.

The average value of the development dynamics of pupils' cognitive interest in physics was calculated using the well-known formula:

$$K_i = \frac{n_3 + n_4 + n_5}{n} \cdot 100\%.$$

where: n_3, n_4, n_5 - are the number of students at the average, above average, and high levels, respectively, *n* is the total number of students.

The overall results of the survey, organized in stages during the pedagogical experiment, are presented in Table 3.5.

Table 3.5.
Results obtained by stages in the pedagogical experiment

Classes		Amount of pupils	The level of development of cognitive interest in physics										K_i (in %)
			Zero		Low		Avarage		Above avarage		High		
			%	n_1	%	n_2	%	n_3	%	n_4	%	n_5	
VII	E	85	4,71	4	77,64	66	11,76	10	4,71	4	1,18	1	17,65
	N	87	5,75	5	74,71	65	12,64	11	5,75	5	1,15	1	19,54
VIII	E	82	4,88	4	73,17	60	12,20	10	6,10	5	1,22	1	19,51
	N	80	5,00	4	76,25	61	15,00	12	3,75	3	0	0	18,75
IX	E	82	3,66	3	71,95	59	15,85	13	7,32	6	1,22	1	24,39
	N	89	3,37	3	71,91	64	15,73	14	7,87	7	1,12	1	24,72
VII	E	80	3,75	3	70,00	56	16,25	13	7,50	6	2,50	2	26,25
	N	82	4,88	4	70,73	58	15,85	13	7,32	6	1,22	1	24,39
VIII	E	85	3,53	3	70,59	60	16,47	14	7,06	6	2,35	2	25,88
	N	87	3,45	3	68,97	60	16,09	14	8,05	7	3,45	3	27,59
IX	E	82	1,22	1	63,42	52	19,51	16	12,20	10	3,66	3	35,37
	N	80	1,25	1	61,25	49	21,25	17	12,50	10	3,75	3	37,50
VII	E	83	1,21	1	43,37	36	24,10	20	24,10	20	7,22	6	55,42
	N	84	3,57	3	71,43	60	15,48	13	8,33	7	1,19	1	25,00

VIII	E	80	0	0	38,75	31	28,75	23	23,75	19	8,75	7	61,25
	N	82	1,22	1	71,95	59	17,07	14	8,54	7	1,22	1	26,83

Based on the calculations, it can be concluded that in order to incorporate applied historical materials on the scientific heritage of medieval Azerbaijani philosophers into the physics course for classes VII-IX, it is necessary to improve the structure and content of the teaching materials provided in the corresponding textbooks. Additionally, the teaching of these topics should be implemented based on the proposed structure. This approach enhances cognitive interest of pupils in physics and fosters the development of national patriotism, a sense of national pride, an understanding of their Turkish identity, knowledge of the history and present state of science, and an appreciation of the role of the scientific heritage of medieval Azerbaijani-Turkish philosophers and modern scientists in the development of world science and culture.

Thus, the following results were obtained from the pedagogical experiment:

1.To integrate applied historical materials on the scientific heritage of medieval Azerbaijani philosophers into the physics course for classes VII-IX, the structure and content of the teaching materials in the corresponding textbooks were adapted to an improved educational model. The topics were taught using an enhanced teaching methodology. This approach laid the foundation for systematic and goal-oriented interdisciplinary and intra-disciplinary integration, ensuring the completion of knowledge of pupils. It also promoted the development of national patriotism, national pride, an understanding of their Turkish identity, and an awareness of the role of Azerbaijani-Turkish philosophers and modern scientists in the advancement of world science and culture. Furthermore, including a "Self-Assessment" block in each lesson helped to increase pupils' personal responsibility in their learning.

2.The incorporation of applied historical materials on the scientific heritage of medieval Azerbaijani philosophers into the physics course for classes VII-IX, structured and enriched based on modern pedagogical and psychological principles tested in

international practice, positively influenced the practical application and relevance of the learning process.

3.The pedagogical experiment confirmed the proposed working hypothesis of this study.

THE MAIN RESULTS OF THE DISSERTATION WORK

1. As one of the ways to develop pupils' understanding of national identity and national pride, as well as their cognitive interest in the subject and their ideas about the unified natural scientific landscape of the world, the life and creativity of Azerbaijani philosophers, including medieval Eastern philosophers, have been integrated into the teaching of physics in grades VII-IX of general educational institutions. The system of applied materials on the subject has been defined, and their use has been scientifically and pedagogically justified.

2. The state of reflection of the theoretical and practical scientific research of medieval Eastern philosophers in the main teaching resources of the "History of Physics" course at the bachelor's and master's levels in "Physics Teaching" staff training at universities was studied. It was found that the scientific heritage of medieval Eastern philosophers, with a history of 800 years of development and a key role in the formation of theoretical and experimental science, is hardly covered in the existing textbooks.

3. The availability of applied training materials related to the research problem in the content of textbooks and methodological materials in general education institutions for the subject of physics was studied. It was determined that these textbooks contain almost no information about the scientific heritage of Azerbaijani philosophers, including Eastern philosophers of the Middle Ages.

4. The potential for solving the problem in dissertations, monographs, scientific-methodological materials, and articles was analyzed. As a result of the research, it was determined that the lives and works of Azerbaijani-Turkish philosophers, including Eastern philosophers from the Middle Ages, have been thoroughly

investigated by both Azerbaijani and foreign scientists. However, it was found that the scientific heritage of these thinkers has not been fully developed in the context of physics teaching in general secondary educational institutions at the dissertation level.

5. The principles and system for selecting applied materials on the scientific heritage of Azerbaijani philosophers, including medieval Eastern philosophers, are defined in the VII-IX grade physics course of general education schools. Based on these principles, the content and application system of historical materials on the scientific heritage of medieval Azerbaijani philosophers in physics education was established.

6. The content of applied training materials on the life and scientific heritage of medieval Eastern philosophers, including Azerbaijani philosophers, proposed for use physics course in the classes VII-IX of general educational institutions, was determined, and the teaching methodology was developed.

7. In order to study the life and creativity of Azerbaijani philosophers, including medieval Eastern philosophers, in the formation of mathematics, physics, and other natural sciences in the history of world science, a special optional course program has been developed. The system and content of the training materials have been determined accordingly.

8. By determining the system of applied materials on the scientific heritage of Azerbaijani philosophers, including medieval Eastern philosophers, in physics teaching for classes VII-IX in general educational institutions, the pedagogical impact on the development of pupils' understanding of national identity and national pride, their cognitive interest in the subject, and their ideas about the unified natural scientific landscape of the world was assessed through an experiment. The working hypothesis of the research was confirmed in the pedagogical experiment.

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