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**ABSTRACT**

of the dissertation submitted for the degree of  
Doctor of Philosophy

**FORMATION OF SCIENTIFIC LITERACY IN STUDENTS  
THROUGH THE APPLICATION OF SITUATION-BASED  
ITEMS IN SCIENCE TEACHING**

Specialization: 5801.01 – Theory and methodology of training and  
upbringing (methodology of the teaching of physics)

Field of science: Pedagogy

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**Nakhchivan – 2025**

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## INTRODUCTION

**Research issue rationale and development rate.** The XXI century is the era of globalized information and developing modern technologies. From the past to the present, the natural sciences taught in general and higher education institutions, especially physics, have played a great role in the development of science and technology. The methods and modern approaches applied in most countries where education is developed suggest that interest in science, scientific creativity and research skills, which are the driving force of socio-economic progress in these countries, are formed in students at an early age. For instance, every four years, the knowledge and skills acquired by 4th and 8th-grade students in mathematics and natural sciences (physics, chemistry, and biology) are measured and evaluated based on reputable international assessment programs such as PISA (The Programme for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study). Azerbaijan also participated in this study program in 2006, 2009, 2011 and 2019. However, the results demonstrating our students' scientific literacy skills were notably low. For example, in 2011 and 2019, TIMSS scored 438 and 427 points (50th out of 58 countries), respectively, on the science assessment, which is much lower than the average for all countries. During the study, it was determined that 25 percent of the items in the question book presented to students on scientific literacy are physics items<sup>1</sup>.

In order to study the state of nature subject education in international practice, we conducted research in the following directions:

- to determine the structure and content of nature subject which elements of science fields are mainly made up of, and what amount of teaching materials from physics are given here;

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<sup>1</sup> Mullis, I. V. S., & Martin, M. O. TIMSS 2019 Assessment Frameworks: [Electronic resource] / Boston College, TIMSS & PIRLS International Study Center. – Boston, 2017. URL:<http://timssandpirls.bc.edu/timss2019/frameworks>

- To determine in which classes science is taught in the countries that ranked first in TIMSS research;
- to determine general learning outcomes, content lines and standards of nature subject to study the overall percentage of physics in specific learning outcomes.

According to the results of the TIMSS evaluation studies, it is known that in the countries that occupy the first 10 places, the teaching of the subject of nature (primary science) in general education institutions starts from the elementary grades. For example, science is taught in Russia, China, Latvia, Norway and Lithuania from the 1st grade, and in Singapore, Korea, Japan and Finland from the 3rd grade<sup>2</sup>.

In Azerbaijan, the subject that can be considered equivalent to "primary science" is the subject of life knowledge, which is taught at the level of primary education, and 70 percent of its content is social issues. The remaining 30% are natural sciences, and only 5-7% of them are educational materials that can be attributed to physics. Thus, the 5th grade life science textbook contains 25 topics, of which only 2 are related to physical science<sup>3</sup>.

When examining the reasons for the low indicators of our students in the TIMSS international assessment studies, it is easy to determine that the standard and learning outcomes of the life science subject do not coincide with the knowledge, skills and achievements evaluated by the international program, including the learning standards and outcomes on which they are based. TIMSS investigates the reasons for the inferiority of our students' performance in international evaluation measures, it becomes clear that the standard and scientific outcome of life science science The knowledge, skills and achievements that the advanced international programs have

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<sup>2</sup> Kelly, D.L., Centurino, V.A.S., Martin, M.O., & Mullis, I.V.S. (Eds.) : [Electronic resource] / Boston College, TIMSS & PIRLS International Study Center. – Boston, 2020 : <https://timssandpirls.bc.edu/timss2019/encyclopedia/>

<sup>3</sup> Məmmədova N. Həyat bilgisi 5-ci sinif dərslik / N.Məmmədova, K. Mahmudova, S.Bəhramova – Bakı: Şərq-Qərb – 2020. – s.88

highlighted do not overlap with the educational standards and results on which they are based.

According to the Decision No. 361 of the Cabinet of Ministers of the Republic of Azerbaijan dated September 29, 2020, "Nature subject" has been included in the curriculum at the general secondary education level. The document mentions the following general learning outcomes for natural science<sup>4</sup>:

- interprets the characteristics of living and non-living nature;
- distinguishes events and processes occurring in nature;
- expresses considerations related to the solution of problems arising from the influence of man on nature, protection of the environment.

It should be noted that in order to accelerate the preparation of the new curriculum and textbooks of natural sciences, the specialists of the Institute of Education have started cooperation with the specialists of the "Alston" publishing house of Singapore. As a result of this cooperation, nature textbook sets (textbook, methodical materials and workbook) have been prepared for classes V and VI, which are widely applied from the 2020/2021 and 2021/2022 academic years.

The three chapters of the Nature-5 textbook consist of teaching materials related to physics. These are the chapters "States and Transformations of Matter", "Energy and Action" and "Light and Vision"<sup>5</sup>. Five chapters of the Nature-6 textbook consist of materials related to physics. These are "Force and movement", "Properties of matter", "Electric circuit and circuit elements", "Generation and propagation of sound", "Transfer of thermal energy" chapters<sup>6</sup>.

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<sup>4</sup> Azərbaycan Respublikasında ümumi təhsilin dövlət standartları. Azərbaycan Respublikasının Qanunvericilik Toplusu, 2020-ci il, № 9, maddə 1233. <https://e-qanun.az/framework/19682>

<sup>5</sup> İslamzadə, Y., Səlimov, R., Abdullayev, E., Ələkbərov, F. və başqaları. Təbiət 5. Dərslük. I hissə, səh.50; II hissə, səh.8,40.

<sup>6</sup> İslamzadə, Y., Səlimov, R., Abdullayev, E., Ələkbərov, F. və başqaları. Təbiət 6. Dərslük. I hissə, səh.8, 72; II hissə, səh.6, 20, 36.

In order for our students to successfully participate in prestigious study programs such as PISA and TIMSS, it is extremely important to build and develop their scientific literacy competence. Assessments in these studies are not carried out separately from physics, chemistry, biology and geography, but based on an interdisciplinary integrative principle.

The consistent underperformance of our students and the thorough analysis of these results have turned the improvement of our country's position in international assessments into a national priority.

This approach aligns with the objectives outlined in the document “*Azerbaijan 2030: National Priorities for Socio-Economic Development*”, approved by the Decree of the President of the Republic of Azerbaijan dated February 2, 2021, particularly concerning the improvement of the content and quality of general education.

“To strengthen general education, which ensures the development of society, the modernization of the education system must continue, curriculum reforms must be deepened, and integrative teaching practices must be advanced.”

Based on this, the country must achieve significant improvements in its standing in international assessments such as PISA, PIRLS, TIMSS, and ICILS<sup>7</sup>.

In addition, the creation of a competency-based, learner-centered curriculum, as stipulated by the first strategic direction of the *State Strategy for the Development of Education in the Republic*

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<sup>7</sup> Azərbaycan 2030: sosial-iqtisadi inkişafa dair Milli Prioritetlər: [Elektron resurs]/ Azərbaycan Respublikası Prezidentinin sərəncamları.–Bakı, – 02 fevral 2021/ URL: <https://president.az/az/articles/view/50474>

of Azerbaijan (approved by the Presidential Decree), further confirms the relevance of this research<sup>8</sup>.

Thus, our study is dedicated to solving the actual problem of investigating the possibilities of applying situational items from physics topics in the teaching of nature subjects one of the ways of forming scientific literacy competence in students..

**Object and subject of the research** – The process of developing students' scientific literacy through the use of physics-based situational tasks in the teaching of the "Science" subject in grades 5-6 of general education institutions, as well as the methodology and techniques of this process.

**Purpose and Objectives of the Research** –The purpose of this research is to promote the development of scientific literacy among students in grades 5–6 of general education institutions by enabling them to apply theoretical knowledge of physics in practice using situational items within the Science curriculum.

To achieve this goal, the following objectives have been set:

- To investigate the current state of scientific literacy formation through the application of physics-based situational content items in the teaching of Science in grades 5–6;
- To conduct a comparative analysis of students' scientific literacy indicators in international assessment programs (PISA and TIMSS), and to evaluate these results within the national context;
- To develop physics-based situational content items for integration into the Science curriculum, and to determine appropriate methods and techniques for their implementation and solution;

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<sup>8</sup> Azərbaycan Respublikasında təhsilin inkişafı üzrə Dövlət Strategiyası» Azərbaycan Prezidentinin Rəsmi internet sahifəsi: [Elektron resurs] / URL: <https://president.az/az/articles/view/9779>

- To identify the didactic principles for the systematic selection of physics-based situational content items in the stages of a Science lesson—namely, “Motivation”, “Investigation”, “Creative Application”, and “Assessment”—and to design appropriate measurement tools based on these principles;
- To examine the impact of physics-based situational content items on students’ scientific literacy through pedagogical experimentation.

**Research methods.** The research was investigated using theoretical analysis (analysis of literature, scientific studies, documents and textbooks on the research problem), survey and pedagogical experiment methods:

- conformity in the content standards of the interdisciplinary integration of physics with chemistry, biology and geography in the science of V-VI classes;
- scientific-methodical analysis of the structure and content of the V-VI classes of nature subject in terms of the content and structure of the teaching materials for physics;
- research of V-VI classes of nature lessons from the point of view of the content of situation items from physics;
- analysis of the results of our students' scientific literacy competence in the 2011 and 2019 TIMSS, 2018 and 2022 PISA international assessment programs in which Azerbaijan participated, based on official sources;
- the methodology of preparation of quantitative and qualitative items with situational content from physics topics in the teaching of Nature subject in grades V-VI;
- degree of measurability of scientific literacy in the summative assessment tools prepared by subject teachers from physics and natural sciences;
- efficient methods and methods of forming students' scientific literacy competence in V-VI class nature classes based on situational items;

- verification of the correctness of the scientific hypothesis put forward in the pedagogical experiment.

**Basic theses for defence.** The main provisions defended in the dissertation are the following:

1. Justification of the role of the use of situational items from physics topics in the formation of scientific literacy competence of students in the teaching of Nature subject in V-VI classes of general education schools and the technology of compiling such items

2. The methodology of using situational items from physics topics for the purpose of forming the scientific literacy competence of students at different stages of the Nature subject lesson in V-VI classes of general education schools

**Scientific novelty of the research.** This is determined by three conditions:

- To reveal ways to solve the problem identified by analyzing the scientific methodical and statistical analysis of our students' poor results in the TIMSS and PISA international studies .

- Scientific-methodological justification of the formation of scientific literacy in students with the application of situational items from physics topics in the V-VI classes of general education schools;

- Development of the methodology for the formation of scientific literacy competence in students through the application of situational items in different contents from physics topics in the "Engagement", "Explore", "Elaborate" and "Evaluation" stages of Nature subject in V-VI classes of general education schools.

**The theoretical and practical significance of this research** lies in the development of principles for selecting, designing, and implementing situational items in the physics section of science teaching for grades 5–6 in general education institutions. Furthermore, it assesses the effectiveness of these items in fostering students' scientific literacy competencies. The findings provide a theoretical foundation for applying situational items in other branches of science, including biology, chemistry, and geography.

Additionally, the incorporation of practically applicable items in the teaching process facilitates the development of students' skills in analysis, justification, and application, which contributes to enhancing student performance in international assessments such as PISA and TIMSS.

**As the experimental basis of the research, for** all branches of pedagogical experience, the secondary schools numbered 116, 297 and 238 of the city of Baku, technical schools named after K.Agayev of Bilesuvar city. A prospective international type high school and a 2-numbered full secondary school in the Quba district of Dağlı were determined.

**Approval and implementation.** The main theoretical provisions of the dissertation have been published in 14 different publications and presented for public discussion.

**The name of the organization where dissertation work is carried out.** Dissertation work was carried out in the Department of Theory and Methodology of Training of the Educational Institute of the Azerbaijan Republic.

The total volume of the dissertation is indicated by noting the volume of the structural sections of the dissertation separately. The dissertation consists of an introduction (11700 characters), three chapters - Chapter I (82,618 characters), Chapter II (70,396 characters), Chapter III (36,018 characters), conclusion (2,879 characters), a list of used literature and appendices. The dissertation consists of a total of 203,611 characters.

## **BASIC CONTENT OF THE DISSERTATION**

In the introduction, the relevance of the chosen topic was justified, the object and subject of the research were indicated, the goals and duties of the research were formulated, the research methods were defined, its novelty, theoretical and practical importance were explained, the methodological basis of the research was indicated, and the main propositions defended were formulated.

Chapter I called "**Theoretical-methodological foundations of the formation of scientific literacy in students in the teaching of**

**science"** consists of 5 sub-chapters. In the first sub-chapter called "*Scientific literacy as a pedagogical concept: its essence and the factors that make it necessary*", the scientific works of various researchers on the essence of the concept of "scientific literacy" and the necessity of its formation were examined, and the statistical results of prestigious international assessment programs were analyzed.

It has been determined that since natural science is an integration of physics, physical geography, biology and chemistry, the role of this subject in the formation of scientific literacy skills in students is important and necessary. In order for students to be able to explain various phenomena, they should have research skills such as evaluating and interpreting scientific research, along with fundamental knowledge of natural sciences. In the formation of this competence, natural science, especially physics teaching materials of this subject, plays an important role.

Thus, the main tasks of natural science can be summarized with two provisions. Science:

- forms basic skills aimed at students to demonstrate a creative and critical approach in solving problems they may encounter in real life, and to be able to make independent decisions. It also creates an inquiry- and inquiry-based learning environment conducive to understanding the general physical laws of natural phenomena;
- it plays the role of a successful transition between the subject of life knowledge improved in accordance with the international experience of natural sciences in elementary grades and the subjects of physics, physical geography, biology and chemistry prepared on the basis of the new curriculum to be taught from grade VII.

In the second sub-chapter called "*Learning the problem in scientific, pedagogical and methodical studies*", the problem of formalizing the scientific approach of students in the study of nature subject discussed at the local and international level.

The paucity of materials that we could obtain from researches on written dissertation works gives us a reason to come to such a conclusion that the researches conducted on the problem we are

investigating are almost non-existent. Dissertation works at the doctoral level corresponding to the problem of our research were not found. In general, in our country, the term scientific literacy has not been researched very widely, on the contrary, although the term situational issues has been used a lot, very few studies have been conducted in this direction in natural sciences.

It should be noted that in the last 24 years (2000-2024), while researching dissertations related to natural science, a dissertation titled "Possibilities and ways of using natural science materials in the teaching of biology" was found<sup>9</sup>. Although this work is not directly related to the problem, the compatibility of the natural science textbook with the subject program, the implementation of the teaching, educational and developmental functions and methodical application of the textbook were investigated here. According to the author, natural science textbooks are satisfactory in terms of providing nature materials, setting questions and tasks. When analyzing natural science textbooks, it is not correct to agree with these ideas. Because if you look at the presentation structure of the topic in the class V textbook, it seems that theoretical information, pictures and questions about the topic are given at the end of each topic. However, although the textbook is designed in a knowledge-oriented structure and content, it is not prepared according to a student-oriented and result-oriented interactive model.

It should be noted that there are local dissertations and articles related to certain parts of our research topic only at the master's level, albeit in small numbers. In one of these works, the method<sup>10</sup> of forming scientific literacy competence in the 7th grade

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<sup>9</sup> Hacıyeva, G.N. Biologiyanın tədrisində təbiətşünaslıq üzrə materiallardan istifadənin imkan və yolları: (VI-VII siniflər): / biologiya üzrə fəlsəfə doktoru dis. / – Bakı, 2005. – 141 s.

<sup>10</sup> Abdurazaqov R.R, Əhmədova X.C. (2019) VII sinif şagirdlərində fizikadan elmi savadlılığın formalaşdırılmasında həyati situasiyalara aid tapşırıqların həllinin rolu // Azərbaycan Texniki Universiteti Elmi əsərlər toplusu. № 2, səh. 190-199.

physics lesson, and in the other one, the system of forming scientific literacy with the case method in the 8th grade physics lesson was investigated<sup>11</sup>. However, what scientific literacy is is not explained, no references are given to the opinions of international researchers about it, and the characteristics and importance of the concept are not purposefully studied.

In the third subsection called *"Learning the local and international experience of the problem: Analysis of educational programs"*, the knowledge of life science, physics and biology programs taught in V and VI classes Comprehensive comparative analysis of the structure and content of the "Science" program taught in foreign countries has been made. It has been determined that, unlike "science", there are standards in life science that consider giving a very small amount of educational material to natural sciences, especially physics. Since the education programs (instructions) for physics and biology students of all classes have very general characteristics, it is not possible to measure and evaluate them with any statistical approach.

Therefore, from the research we have conducted, it has become clear that, although there are certain differences in the curriculum taught in classes V and VI of the countries whose curricula are examined, they essentially have the same curriculum. Particularly in the establishment of "science" in Singapore and England, the scientific and scientific results are admirable. The reason for this is that Singapore has integrated its self-education system on the basis of the British system.

Another interesting nuance is that the content lines and standards of natural science taught in grades V and VI in our country are similar to Singapore. The reason for this is the cooperation with Singapore experts in the process of preparing nature curriculum and textbooks within the framework of "Reserve Textbook" of our

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<sup>11</sup> Abdurazaqov R.R., Əhmədova X.C. (2019) VII sinif şagirdlərində fizikadan elmi savadlılığın formalaşdırılmasında həyati situasiyalara aid tapşırıqların həllinin rolu // Azərbaycan Texniki Universiteti Elmi əsərlər toplusu. № 2, səh. 190-199.

country. As a result, the natural science program has been specified, and the number of learning outcomes allocated to physics has been increased

*"Analysis of the results of our students on the scientific literacy competence in the PISA study program "* It has been analyzed in detail. Here, as an example, the results of the last PISA surveys in 2022 are depicted, and the characteristics and accuracy levels of the measuring instruments are explained. From the analysis of the results, it became clear that 66% of our students showed results below level 2, while 34% showed results at level 2 and above. The average international indicator of countries with students who could not rise to the 2nd level is 24%. According to PISA calculations, none of our students were able to rise to the highest level - the 6th level. The average indicator of the country's internationalism, based on students who rose to the 5th and 6th levels, is 7%. As can be seen from these statistical results, the main problem is not that our students cannot rise to the 5th and 6th levels , but that 66% of them are below the 2nd level <sup>12</sup>.

It has become known from research that the types of questions that create serious problems for our students are the development, establishment and evaluation of scientific research.

It was found out from the research that the types of questions that cause serious problems for our students are the design, construction and evaluation of scientific research.

In the present case, it would not be fair to expect our students to answer such questions and to accuse them of incompetence, because in recent years we have been able to draw some attention to scientific research only at the level of universities. Thus, it can be concluded that by participating in the PISA research, we can determine the current state of our education system, what the priorities of modern education are, and what position we are in. In

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<sup>12</sup> OECD (2023), PISA 2022 Results (Volume I): The State of Learning and Equity in Education, PISA, OECD Publishing, Paris, <https://doi.org/10.1787/531f23881-en> . URL: [https://www.oecd.org/pisa/data/pisa2022technicalreport/PISA-2022-Technical-Report-Annex A-Item-Pool-Classification.xlsx](https://www.oecd.org/pisa/data/pisa2022technicalreport/PISA-2022-Technical-Report-Annex-A-Item-Pool-Classification.xlsx)

this way, having a clear vision plays a key role in identifying practical and proven solutions for results-oriented education.

In the fifth sub-chapter called "*Comparative analysis of the content of teaching materials of physics in science from the point of view of application of situation content tasks in V and VI grade textbooks*" research was carried out according to the topic. It turned out that 8 sections of natural science taught in grades V-VI are made up of teaching materials related to physics. These are "States and transformation of matter" (6 hours) in interdisciplinary integration with chemistry in Nature 5, "Energy and motion" (8 hours) and "Light and vision" (5 hours) integrated with biology<sup>13</sup>. In Nature 6, "Force and motion" (11 hours), "Properties of matter" integrated with chemistry (7 hours), "Electric circuit and circuit elements" (6 hours), "Generation and propagation of sound" (7 hours) and "Heat energy transfer" (5 hours) sections. Our analysis of natural science textbooks revealed that situational items, which play an important role in the formation of scientific literacy competence, are not used in the textbooks. The items given in these textbooks mainly serve to check and strengthen new knowledge.

**"Methodology of formation of scientific literacy in students through the application of items with situational content from physics topics in the teaching of the subject "Nature"** , consists of four sub-chapters. In the first sub-chapter called "*didactic principles of selecting the ideas from physics to situation in the study of nature subject*", the general didactic training principles for the preparation and selection of situational items from physics topics in Nature subject are defined.

General didactic training principles have been outlined for its preparation and selection . These principles have been successfully derived from long years of experience and are based on theory and practice by our magnificent experts - psychological scientists . These are the following:

- the edifying and developing principle of education;
- the principle of relevance of science to life;
- scientific principle of education;

- the principle of systematicity and succession of education;
- principle of religiousness in education and implementation of ICT;
- The principle of strengthening the knowledge in training;
- the principle of consciousness and activity in education;
- principle of conformity of education;
- the principle of creating appropriate conditions for education;
- principle of collaboration in education;
- principle of integratism in education;
- the principle of taking into account age and individual characteristics;
- the principle of popularizing ways to solve global problems;
- principle of historical and geographical analysis.

Examples based on some of the principles applied in selecting the situasiya examples that we researched in the research work are shown.

In the second paragraph, which is called "*Determination of the structure, basis and characteristics of the scientific theories applied from physics topics in the study of nature subject*", it is stated that the scientific principles prepared on the basis of scientific materials from physics are discussed in detail . It is based on ensuring the axis relevance. It should be noted that solving the problem posed in political matters from physics – applying knowledge of certain physical theories, laws and concepts – is a particular problem in the real world. It means to describe the difference. These types of issues also provide other relevance in science. Therefore, it allows a better understanding of theories, laws, events and concepts from physics and their practical applications .

Here, both the preparation of physical and situational issues and the technology of determining its structure and characteristics are also explained on the basis of concrete samples. It is noted that the study of certain natural phenomena by means of the principles of situation is not sufficient to gain the knowledge gained in the field of

only one science of nature, for example physics or biology. . In order to solve the situation, it is necessary to apply knowledge and skills regarding the laws and theories of other natural scientists. Accordingly, the connection from physics to situation should be taken into account in terms of its integration with other aspects of nature. In this regard, examples of situational ideas in the global context used in international investigations are given and a methodical analysis of each question is given based on the suggestions.

*The formation of the formation of scientific knowledge in the students through the principles of physics and situation in the study of nature subject" , it is stated that the main principles of the teacher in his own lesson are It can use various methods to achieve simplicity and effectiveness. Appropriate methods have been proposed according to the volume of the subject, the degree of difficulty and the application areas.*

Here, the methods that science teachers can use in the formation of science have been summarized and each method has been analyzed on the basis of concrete samples.

suitable for use in the application of physical and situational issues .

- research/Inquiry based learning
- flipped method
- project-based learning
- case method
- problem solving

Here, the benefits of using both methods and their positive and negative characteristics are analyzed.

The fourth sub-chapter, which is called *"The method of formalizing the scientific knowledge of the students in the study of nature subject through the principles of physics and situation"*, deals with the stages of the subjects in the natural sciences. The practical situation of the situational principles is investigated. It is noted that, although V class nature classrooms are prepared on the basis of the 5E model, the course stages are not given systematically and

sequentially. The topics do not start with situations that aim to arouse interest in students, but rather with the provision of theoretical information.

The following main demands have been made regarding the situation presented in the first page of the section :

- The presented situation should include the main issues or topics that attract the attention of the whole section;
- One should consider the historical facts and contemporary achievements of science or science;
- be essentially in a global or national context;
- Appropriate descriptions that reflect the situation, short text and a few appropriate questions;
- What you will learn in this section should be recorded briefly and clearly.

The following demands have been determined for the course's introductory phase.

- It should be relevant to daily life;
- The text of the situation should be as short and clear as possible;
- Students should be prepared for new knowledge by building on the knowledge they have gained;
- It should create more interest in the subject to be learned and be able to provide effective communication to the students;
- The posing of questions should require you to base your answers;
- It should allow the students to first determine their knowledge and misconceptions about the subject .

on the basis of scientific materials from physics in the fields of "Maraqoyatma", "Tədqiqat" and "Creative application (Deep - research )" . Examples of the methodology of using possible situations have been presented.

**Named “Pedagogical experiment and its results”** consists of two sub-chapters. It is stated here that the main purpose of the experiment is to check the accuracy of the training obligation .

Therefore, the obligation of the training is to effectively formalize the skill of the students in the study of nature subject in the V and VI classes of the general secondary education level. It is possible to realize that the theoretical knowledge gained through learning the scientific materials related to physics can be systematically used at various stages of the course . nature, production, life and technology. Make use of the situational principles that contain the basic principles of the processes . The pedagogical experience for the purpose of examination is carried out in three stages: instructive , exploratory and instructive stages. The purpose and duties of each stage have been determined .

the principles of science on the basis of educational materials related to physics in nature courses, the pedagogical experience was organized in three stages: exploratory, investigative, instructive. experience

The first stage of the experiment was held in the 2021/2022 academic year. In this context, the practical situation of scientific theories from physics was investigated in the nature classroom. At this time, the following items were performed:

- To determine the current situation of utilizing the principles of physics and situation in V and VI class nature classrooms ;
- Analysis of lesson models in the sample of physics-related educational materials presented in V and VI class nature classrooms ;
- nature subjectscholars from KSQ's situasiya discussions and the review of their quality;
- Analysis of the construction, background and characteristics of the situational instruments used in programs for valuing international student achievements, such as PISA , and the contribution of our students to their bravery in these programs . In addition , the evaluation of successful performers;
- To learn about the rough experiences of some foreign countries and contemporary approaches of experts and engineers regarding the nature and formation of scientific knowledge ;

- Investigating the application of contemporary approaches used by the PISA research program, which is an influential organization in measuring scientific merit, to the formation of scientific merit;

- Selection of control and experiment classes for the completion of the experiment .

, students were presented with clear and multiple correct answer situaisya questions on certain scientific materials related to physics that the researcher selected . These tips were presented to the students before they learned the topics related to the appropriate division of physics. Considering that the participants in the investigation process had not learned about these issues before, it was obvious that they were not able to answer the questions in both control and experimental classes . It was determined that the test results of the RDs were at the same level. Even though the situations given are familiar from daily life, they are still not learned about the laws and regulations between the events , at best they are false assumptions and unfounded assumptions. The localities continued in large numbers.

The rest of the teachers are like 100 fish measuring device in KSQ, each of them is formal

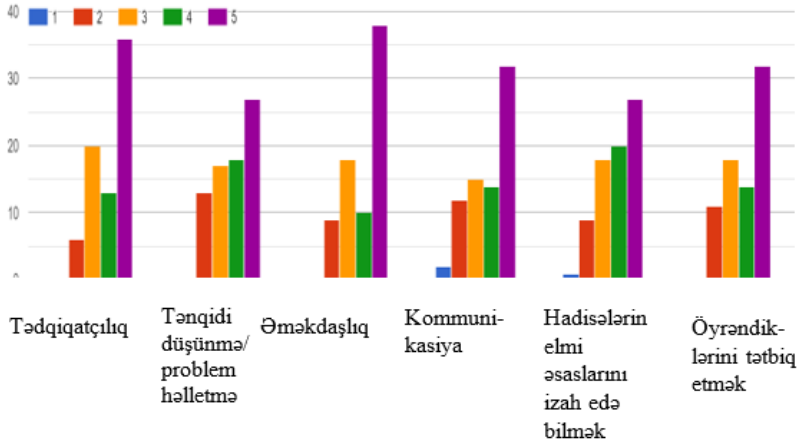
They use closed tests with one question valued at 20 points. In other words, the study of the subjects of nature subjectrelated to physics - was implemented in a spiritual, teacher-oriented course form .

an online survey was conducted among V and VI class nature subjectteachers . In their natural classes and in their business books, - contemporary scientific skills of the students in accordance with the scientific materials related to physical rocks (investigative, critical thinking , labor , communication, etc. ) Explaining the scientific principles of water, how to understand it His ideas on how effective it would be were learned . The following question was presented to - the teachers .

Question. Evaluate in appropriate numbers the effectiveness of the training materials related to physics given in nature subjectclasses and workbooks in the formation of the following skills

in students . The analysis of the results of the answers given is depicted in diagram 1.

**Diagram 1. Effectiveness of tasks related to physics in the nature textbook set in inculcating modern learning skills**



The second stage of the expertise in the 2022/2023 academic year – the exploratory survey was completed. It is our aim to serve to clarify the issues by dividing the multi-contextual situations presented to the students in the experimental classes in this period . He aimed to formalize warriorship. The questions in the given situations were used to explain the students' daily life events in five ways and to base their ideas on them, to establish projects by applying the knowledge they gained and to establish the basis of the established studies. It was requested to value the futures. Taking these into consideration, it is possible to separate them into certain levels based on the students' answers . As a condition of levels, 2, 3, 4 and 5 values and honeys suitable for them were determined.

Elmi warship was divided into the following four lines based on these levels.

a. 2 – He gives wrong answers, he is not able to explain the events in a practical way, he is not able to model the given plans and processes and evaluate them.

b. 3 – He partially explains the events in fifty different ways, partially and incorrectly bases his ideas, does not model the given plans and processes freely and cannot evaluate them.

c. 4 – Explains events in various ways, bases his ideas, models the given plans and processes, but does not evaluate them clearly and explain their paths. There is tension in the world.

d. 5 – He explains the events in fifty ways and fully bases his ideas , establishes the model of the given plans and processes, evaluates them and explains their stages.

, the survey was implemented with the aim of measuring the current level of spirituality among the students . 120 students in the experimental classes selected for V classes and a total of 122 students in the control classes were invited to the experiment. 124 students in selected experimental classes and 122 students in control classes participated in the experiment. Even if we take into account that the students in all classes did not have the knowledge and skills regarding the selected topics , they would not be able to explain their own ideas in fifty ways and to base their ideas. First, the results obtained from the investigative experiment also confirm this idea. Polling time would show its essence seriously in other respects. It may be observed that the students did not have enough time to write answers to open questions and to explain and justify their ideas. This problem is observed in the statistical indicators of our students in the PISA study program. 66% of our students decide on valuation levels below level 2 based on levels 1-6. The results of the examination on the schools are depicted on the table.

As it can be seen from the table, neither the experimental nor the control class students were able to get the fees with 4 and 5 training levels. .

The last, educational phase of the experiment was realized in the 2023/2024 academic year . The main goal of this course is to learn the scientific materials of nature subjectin V and VI classes and to apply situational problems in various courses . In fact , it has proved its effectiveness in formalizing the intellectual spirituality of the students . It should be noted that the experience of the teachers

and the methods they use can provide different results in the understanding and application of the given materials, thus providing objective evaluation. However, both the school and the classes were hand-selected so that, although the students' levels of education were not the same, they were close to each other. In this period , experiments were carried out on the basis of scientific materials related to physics in accordance with the subject of V and VI nature subject“Materials and their properties” .

Therefore, the materials for the "States and transformations of matter" section in the V class of nature courses and the "Characteristics of matter" section materials in the VI class were taken into consideration. Additional material and situational suggestions were presented to the students of the experimental classes on the topics that were considered to be taught in the department.

### **Calendar 1. The result of the first examination on the schools**

School	Class		Number of Shagird	Values on scores				The average value of the values
				2	3	4	5	
Baku city Binəqədi rayon 297 li full secondary school	E	$V^c$	30	18	12	0	0	2.40
	C	$V^c$	28	16	12	0	0	2.42
	E	$VI^c$	27	14	13	0	0	2.48
	C	$VI^d$	26	15	11	0	0	2.42
Baku city Khatai district Full secondary school with number 116	E	$V^d$	25	13	12	0	0	2.48
	C	$V^c$	27	14	13	0	0	2.48
	E	$VI^d$	29	16	13	0	0	2.45
	C	$VI^c$	30	17	13	0	0	2.43
Baku city Nizami district	E	$V^c$	24	12	12	0	0	2.50
	C	$V^c$	24	11	13	0	0	2.54

Full secondary school with number 238	E	$VI^d$	26	14	12	0	0	2.46
	C	$VI^c$	24	16	8	0	0	2.33
Quba district Mountainous self	E	$V^a$	16	8	8	0	0	2.50
	C	$V^b$	17	9	8	0	0	2.47
2nd full secondary school	E	$VI^a$	18	10	8	0	0	2.44
	C	$VI^b$	17	9	8	0	0	2.47
Biləsuvar city technical sciences-oriented international school named after K.Ağayev	E	$V^a$	25	13	12	0	0	2.48
	C	$V^b$	26	13	13	0	0	2.50
	E	$VI^a$	24	13	11	0	0	2.45
	C	$VI^d$	25	13	12	0	0	2.48

the control classes , the teacher only benefited from the lessons given in the classroom during class time.

In the course of time, the following issues have found their essence:

- Preparation of a sample model for the application of scientific principles and situational theories on topics selected from physics in V and VI class nature courses in various stages of the course.

- , certain effective forms and methods of education are used in the application of situational principles in various stages of the course on selected subjects related to physics . to be done.

- To teach science teachers the technique and method of preparation of situational problems with quantity and quality characteristics related to subjects related to physics in the teaching of V and VI class natural science.

4 classes were used to determine the extent to which the students in the experimental and control classes demonstrated their susceptibility to pro-warness, taking into account the data given. and we researched the statistics of the students who received 5 prizes. In

order to determine the interest rate of the class of students who fully demonstrate their skill, it is necessary to divide the number of students who received 4 and 5 values by the total number of students in the class:

$$E = \frac{K}{N} \cdot 100\%. \quad (1)$$

Here, K is the number of students who received 4 and 5, N is the total number of students in the class, and E is the number of students who demonstrated religious wars per class. In addition, we identified standard trend or mid-quadratic trend indicators that show the level at which the values of the students are changing <sup>13;14</sup>.

$$s^2 = \frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2 \quad \rightarrow \quad s = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2} \quad (2)$$

By the way  $s^2$ - it shows the variation of the given set of information, the standard tendency of the given set of information, if you repeat the values in the given sample again and again, the standard tendency of the sample  $s_i$  is calculated with the following principle .

$$x = x_1, x_2, x_3 \dots x_n. \quad (3)$$

$$f = f_1, f_2, f_3 \dots, f_n. \quad (4)$$

Here x is the repeated values, the number of repetitions in accordance with the bill :

$$s = \sqrt{\frac{1}{n-1} \sum_{i=1}^n f_i (x_i - \bar{x})^2} \quad (5)$$

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<sup>13</sup> Bhandari, P. (2024, March 28). How to Calculate Standard Deviation (Guide) | Calculator & Examples. Scribbr: [Electron resource] / URL: <https://www.scribbr.co.uk/stats/standard-deviation-meaning/> (2 Apr 2024)

<sup>14</sup> Population, Derivation & sample; Solved Examples. BYJUS / [electronic resource] URL: <https://byjus.com/maths/standard-deviation-formula/>

Here  $s$  is the standard tendency,  $n$  is the number of students in the class,  $x_i$ - is the amount students can receive.

Each of the values shows  $\bar{x}$ - the average of the value of the students per class,  $f_i$ - the number of those who received the appropriate value per class.

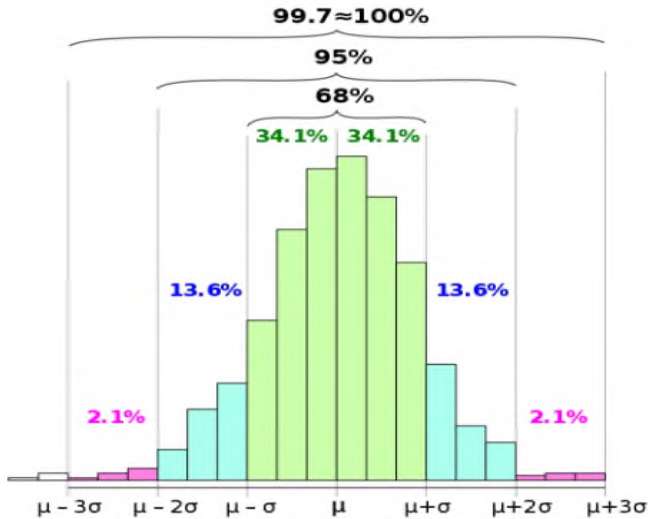
always shared up to the standard trend . Essentially, according to Abraham de Moivre's normal division law, the distribution of information down the middle to one, two and three standard tendencies works as shown in diagram 2 <sup>15</sup>.

According to Chebyshev's theorem, in probability allocations, the same amount of information is always shared, with a standard tendency up or down from the middle of the information base.

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<sup>15</sup> Walker, Helen M. and Lev J., De Moivre on the Law of Normal Probability, In Smith, David Eugene, 1985. A Source Book in Mathematics, Dover, ISBN 0 – 486 – 64690 – 4, 2, 153 –171, 1990

**Diagram 2. Standart meyillənmənin təsviri**



In Diagram 2, the sharing of standard inclination time information is depicted .

That is, the time to divide the information down the middle to a standard tendency is between  $(\mu - \sigma)$  and  $(\mu + \sigma)$  68% of all information is stored among:

$$P = (\mu - \sigma) + (\mu + \sigma). \quad (6)$$

This is also called the empirical record <sup>16</sup>.

In this stage, it is possible to formalize the spiritual succession of students by applying the situational studies prepared on the basis of optionally selected scientific materials from physics . Measurement of body weight was implemented.

The results obtained are depicted in table 2.

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<sup>16</sup> Team, C. (2023, November 21). Empirical rule. Corporate Finance Institute. URL: <https://corporatefinanceinstitute.com/resources/data-science/empirical-rule/>

### Cədvəl 3.2.1. The results of the experiment on schools

School	Classes		Number of Shagird	Values on honey				Scientific knowledge	Standard diffusion	Values the middle of the number
				2	3	4	5			
Baku city Binaqədi rayonu 297 li full secondary school	E	$V^c$	30	3	8	13	6	63%	0.91	3.73
	C	$V^c$	28	6	11	10	1	39%	0.83	3.21
	E	$VI^c$	27	4	8	11	4	55%	0.93	3.56
	C	$VI^d$	26	6	10	9	1	38%	0.85	3.19
Baku city Khatai district Full secondary school with number 116	E	$V^d$	25	3	7	10	5	60%	0.95	3.68
	C	$V^c$	27	5	11	9	2	41%	0.87	3.30
	E	$VI^d$	29	3	9	12	5	59%	0.90	3.66
	C	$VI^c$	30	6	12	10	2	40%	0.88	3.27
Baku city Nizami rayonu,	E	$V^c$	24	2	7	10	5	62%	0.90	3.75
	C	$V^c$	24	5	9	8	2	42%	0.91	3.29

238 li full secondary school	E	$VI^d$	26	3	9	11	3	54 %	0.86	3.54
	C	$VI^c$	24	6	8	9	1	42 %	0.88	3.21
Qubarayon, Dağlı town 2-degree full secondary school	E	$V^a$	16	1	4	6	5	69 %	0.93	3.94
	C	$V^b$	17	3	6	6	2	47 %	0.94	3.41
	E	$VI^a$	18	2	6	7	3	55 %	0.92	3.61
	C	$VI^b$	17	3	7	7	0	41 %	0.75	3.24
Bilasuvayr district physics-mathematics oriented boarding school-lyceum	E	$V^a$	25	2	5	10	8	72 %	0.94	3.96
	C	$V^b$	26	4	9	9	4	50 %	0.95	3.50
	E	$VI^a$	24	3	6	9	6	62 %	0.99	3.75
	C	$VI^d$	25	5	7	11	2	52 %	0.91	3.40

As can be seen from the table, when we apply the empirical record for the standard allocation, -the range in which 68% of the experimental and control class students accumulated differs significantly, that is, the range of values collected by the experimental class students It was quite high compared to the control class. This shows that, in the experimental class students of V and VI classes, where the situational problems were applied in interpreting the scientific materials related to nature subject there was a strong skill in skill. It has had a significant positive impact on the formalization of the institution.

The researches allowed us to reach the following **conclusions**:

1. A scientific-methodological and statistical analysis of our students' weak performance in scientific literacy in the international studies TIMSS and PISA revealed the significant role of applying situational items in teaching science subjects, particularly physics, in solving this problem.
2. The application of situational items in learning physics-related content within the science curriculum for grades 5–6 in general education institutions was scientifically and methodologically substantiated as a way to develop students' scientific literacy competencies. The analysis conducted during the study showed that situational tasks serve as a primary assessment tool in evaluating students' scientific literacy levels. These tasks present real-life problems that enable assessment of students' abilities to apply scientific concepts, establish cause-effect relationships, provide scientific justifications, and propose alternative solutions.
3. A methodology was developed for forming scientific literacy competencies in students through the use of situational items in physics across different content areas during the "Motivation," "Investigation," "Creative Application," and "Assessment" stages of science lessons for grades 5–6 in general education institutions.
4. The results of the pedagogical experiment confirmed the scientific hypothesis of the study: students' scientific literacy competencies at the general secondary education level in grades 5 and 6 can be effectively developed if situational tasks—incorporating scientific principles of natural, industrial, life, and technological processes—are systematically used throughout the different stages of lessons while studying physics content.

Based on the research results and aiming for a comprehensive approach to solving the problem, we propose conducting further studies in the following directions:

1. Investigating the role of situational tasks in the formation of scientific literacy competencies during the teaching of the "Life Knowledge" subject to primary school students.
2. Studying the possibilities of developing scientific literacy competencies in students through separate teaching of biology, geography, physics, and chemistry subjects at the general secondary education level (grades 7–9).
3. Exploring opportunities to increase the inclusion of situational tasks in new textbooks, workbooks, and supplementary educational resources for science subjects.
4. Considering the inclusion of courses or elective subjects in higher education teacher training curricula that address solutions to this problem.
5. Systematically integrating principles for developing and selecting assessment and evaluation tools that promote scientific literacy into the methodology courses for natural science teacher training (physics, chemistry, biology).
6. Providing recommendations in methodological guides for teachers on the technology of using situational assessment tools for formative and summative assessments.

**The main results of the dissertation have been published in the following scientific works.**

1. Ağacanlı, Ə.X. Təbiət fənninin enerji və işıq bölmələrində elmi savadlılığın formalaşdırılmasında beynəlxalq standartlara əsaslanan situasiya məsələlərinin rolu // “Fizika-Riyaziyyat Təhsili: Reallıqlar, Tələblər və Perspektivlər Respublika Elmi Konfransı, – Bakı: – 2021, s.195-196.
2. Ağacanlı, Ə.X. Azərbaycanda ümumi təhsilin inkişaf tendensiyası zəminində “təbiət” fənnini zəruri edən amillər//Müasir təhsilin stratejiyaları: uğurlar və çağırışlar / Naxçıvan Beynəlxalq Elmi Konfransı. Naxçıvan, 26-27 noyabr 2021, s.703-705.

3. Ağacanlı, Ə.X. İbtidai sinif şagirdlərində elmi savadlılıq bacarığının formalaşdırılması problemi//Bakı: Doktorantların və gənc tədqiqatçıların XXV Respublika elmi konfransının materialları, 23-24 noyabr 2022, s.170-173.
4. Ağacanlı, A. Azərbaycanca araşdırma esaslı “doğa” bilimi öyrətmənin önemi və vəzifələri // 5. International Anatolian Scientific Research Congress. Həkkəri: 2023, s.17-21, 1560.
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8. Ali Aghajanli Khudaverdi. Organization of competence-based training in the teaching of the Nature subject in general education schools/Ali Aghajanli Khudaverdi//Науковий вісник Південно-українського національного педагогічного університету імені К. Д. Ушинського = Scientific bulletin of South Ukrainian National Pedagogical University named after K. D. Ushynsky: наук. журнал. Одесса : ПНПУ ім. К. Д. Ушинського, 2023, № 3(144), с. 41-45.
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12. Ağacanlı, Ə.X. PISA 2022 tədqiqatlarında azərbaycanlı şagirdlərin elmi savadlılıq səriştəsi üzrə nəticələrinin təhlili// Bakı: Azərbaycan Respublikasının Təhsil İnstitutunun Elmi əsərləri. 2024. №1, s. 36-39.

13. Ağacanlı.Ə.X “Təbiət” fənni üzrə fizikadan integrativ situasiya məsələlərinin tətbiqi ilə şagirdlərdə elmi savadlılığın formalaşdırılması təcrübəsindən //Gəncə: Gəncə Dövlət Universitetinin Elmi Xəbərləri, –2024. №2, – s. 88-93.

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The defense will be held on the 30 June 2025 at 10<sup>00</sup> at the meeting of BFD 2.40/2 One-time Dissertation Council established on the basis of the FD 2.40 Dissertation Council of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating Nakhchivan Teachers Institute

Adress: AZ 7003, Nakhchivan Autonomous Republic, Nakhchivan city, Heydar Aliyev avenue 1, Nakhchivan Teachers Institute

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Electronic version of dissertation and its abstract are available on the official website ([www.nmi.edu.az](http://www.nmi.edu.az)) of Nakhchivan Teachers Institute.

Abstract was sent to the required addresses on 29 may 2025.

Signed for print: 23.05.2025  
Paper format: 60/84, 16/1  
Volume: 40.661  
Number of hard copies: 20