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Organization of competence-based training in the teaching of the Nature subject in general education schools

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The main aim of the article is to study the organization of the Nature subject in the competence-based teaching at schools. In recent years, the active participation of our Republic in various research programs on the assessment of student achievements has led to positive changes in textbook policy. In such programs (such as TIMSS and PISA), the reading, mathematical, and scientific literacy skills of students are studied and evaluated with specially designed tools. It should be noted that according to the results of the latest TIMSS study, our students were able to demonstrate high mathematical literacy skills. Unfortunately, their scientific literacy scores were lower than the average research score. However, the formation of scientific literacy in the natural sciences is extremely important in training competent young people for the future. In the countries whose students show high results in the TIMSS and PISA research programs (Singapore, China, South Korea, Finland, etc.), the formation of scientific literacy competence in the teaching of Natural Sciences is the main goal of national education. In the article, the way to solve the problem related to the formation of scientific literacy competence in our students at the general secondary education level with the teaching of the integrative "Nature" subject was studied; the importance and necessity of studying this subject were justified. The results of Azerbaijani students in the field of Natural Sciences in comparison with international studies are not satisfactory, the reason for this is that students do not have enough knowledge of scientific concepts and laws in Natural Sciences, and they have difficulty answering real-life situational tasks.

Application importance: this theory can be implemented in general education schools.

Keywords: *scientific literacy, competence, science, TIMSS 2019, PISA 2018, student achievement.*

Introduction. The purpose of the Natural Science training is to form scientific literacy skills in students, to instill in them the ability to apply the acquired knowledge to solving situational problems of various content. In order to successfully realize this goal, a conceptual approach to the process of improving and renewing the teaching of Natural Sciences is implemented in our country. Thus, "Life knowledge" at the compulsory primary education level, Natural Sciences curricula at the secondary and full secondary education levels of the general education level are re-analyzed and evaluated. On the basis of the prepared new subject curricula, the concepts of textbook sets for "Life knowledge" for primary grades, "Nature" for grades V-VI, and Biology, Physics and Chemistry for grades VII-XI are developed, textbooks are compiled and their pilot testing is carried out (https://edu.gov.az/uploads/telim-materiallari/2021/yeni-tedris-ilinde-nezerde-tutulan-fealiyyetler.pdf).

Formulation of the problem. In order to move to a new stage in the educational system of our Republic, like other countries, the study of student achievements and determination of the ways to raise their level are considered important issues. In recent years, the participation of Azerbaijani students in international studies such as PISA (The Program for International Student Assessment) and TIMSS (The Trends in International Mathematics and Science Study) gives reason to say this. Countries participating in research programs such as TIMSS and PISA can identify gaps in their education system based on the educational achievements of 4th and 8th grade students in Mathematics and Natural Sciences, as well as determine their educational policy and the level it can be compared to in the framework of international standards. It should be noted that various reasons affect the results of research. Since textbooks play an important role in the learning process in our education system, poor performance is mainly due to deficiencies in textbook content and teaching. Currently, as a result of the textbook policy conducted in our Republic, it is being improved based on global international experience. However, there are still some shortcomings in the process of developing and improving textbooks. A certain part of these shortcomings was discovered as a result of the conducted international assessment studies. In order to eliminate them and adapt our education to the requirements of international standards, the "Reserve textbook" project was brought to the agenda (Babayeva, 2021: 132).

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The main part. Thus, according to the Decree of the Cabinet of Ministers of the Republic of Azerbaijan dated 24.11.2016, in order to provide high-quality educational institutions with new-generation variant textbooks, reserve textbook sets for Mathematics and Azerbaijani language subjects were compiled for school preparatory groups and elementary school students. Within the project, students and teachers were provided with additional teaching and learning resources (TIMSS, 2019: 10).

The improvement of the textbook set has led to an increase in the mathematical literacy of our students in the TIMSS studies conducted in 2019 for IV classes.

This targeted approach, perhaps unsurprisingly, produced uneven results for Azerbaijani students in TIMSS 2019, with results for mathematical literacy differing significantly from results for scientific literacy.

At the same time, when the results of the countries participating in the PISA research conducted in 2018 are announced, it becomes clear that Azerbaijani students scored lower than the national average in Reading, Mathematics and Natural Sciences [OECD, PISA 2018].

In TIMSS 2019, our students participated only in studies of IV classes.

The questions used in the study cover three content areas: Life Sciences, Physical Sciences (Physics, Chemistry and Biology) and Geography (Earth Sciences) as given in Table 1. The coverage of questions corresponding to each content line is 45, 35 and 20 percent, respectively.

Table 1. Medical sciences – 4th class (TIMSS 2019 Framework)

Content lines	*Percent of questions*
Life Sciences	45 %
Science of Physics	35 %
Ceography	20 %

Table 2 shows which cognitive areas are covered by the questions used in the study and their phases of coverage by questions.

As it can be seen here, a total of 80% of the questions cover Knowledge and Application of cognitive domains, and 20% cover Reasoning.

Table 2. Medical sciences – 4th class (TIMSS 2019 Framework)

Cognitive domains	*Persent of questions*
Knowledge	40 %
Application	40 %
Justification	20%

Table 3 shows the indicators of scientific literacy in Natural Sciences of the top ten countries in TIMSS research. Our students scored 427 points and ranked 50th out of 64 countries in this study. Considering that the international average score in the study is 500 and the country in the first place scored 595 points, the results of our students on scientific literacy were very low. As the result is very poor and 80% of the questions cover knowledge and application, it seems that students have difficulty answering these types of questions.

Table 3. Average achievement in scientific knowledge [IEA's TIMSS 2019].

№	Countries	Average price indicator
1	Singapore	595
2	Korea,	588
3	Japan	562
4	China, Taipei	558
5	Finland	555
6	Latvia	542
7	Norway	539
8	USA	539
9	Lithuania	538
	International avarage indicator	500
50	Azerbaijan	427

One of the difficult questions used in the researches is given as an example in Figure 1.

The structure of the question as follows:

Content line: *Life Sciences*

Cognitive field*: Application*

Description*: It uses the food web to determine which animals are competitors.*

Question: The Figure shows the food web in a forest ecosystem.

Based on the food chain above, identify which two animals compete for food.

Answer:

1. Bug
2. Rabbit

Figure 1. (Mullis et al., 2020: 609)

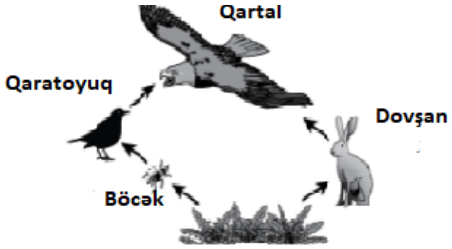

Diagram1. Exhibit 2.13.4 (Mullis et al., 2020: 609)

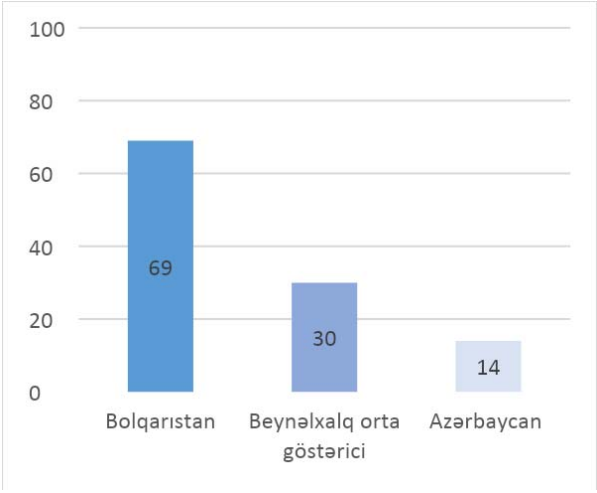

Diagram 1 shows the country with the best results for the above question, the international average and the result of Azerbaijan. Apparently, Azerbaijani students had difficulty in answering the real-life situation question, which is the highest level of difficulty in the exam category that is related to Earth Science and requires application skills, and scored below the international average.

Discussions. The existence of the above-mentioned results of the application of Natural Science depends on the effective application of the textbook set on Natural Science. Since this subject is new, it needs to be constantly monitored at different stages, and it will be necessary to take into account the problems that may arise in connection with the teaching of the content and to solve them by taking advantage of modern practices. Timely and prompt solution of problems related to the teaching and effectiveness of the subject will have a positive effect on the quality of education. There can be various reasons why students perform poorly. One of the main reasons is that they do not acquire sufficient scientific literacy competence in Natural Sciences. The weak scientific literacy competence indicates that the content knowledge of the students on the questions used in the study is insufficient and that they cannot apply the acquired knowledge for solving the tasks given in the context of real life.

Until 2008, natural science was taught in the 1st-5th grades in our republic. After 2008, this subject was replaced by the subject of Life Science, and topics related to Natural Sciences were also included in the program of this subject. From our research, it was determined that the integration of the basics of Natural Sciences in the structure and content of the Life Sciences textbook set does not match modern trends.

In the new edition of "State Standards in General Education", the subject "Nature" is included in the subject block at the secondary education level (ARÜTDS, 2020: 23).

The role and importance of the subject "Nature" in the formation of scientific knowledge.

Formation of scientific literacy/knowledge in natural sciences is extremely important for training competent individuals. Scientific literacy is a necessary element of education in our modern society based on science and technology. It is important for educating all citizens about the fundamentals of science, not just for active or early-career academics [McPhearson et al 2008]. The PISA organization presents the term "scientific literacy" as the ability to engage with various issues and scientific ideas related to science and education as a reflective citizen. PISA's definition of scientific literacy includes being able to explain phenomena scientifically, evaluate scientific research and apply acquired scientific knowledge to real-life situations, and interpret data and evidence scientifically. In order to develop scientific literacy competence and to be able to find solutions to problems that students will encounter in real life, they should acquire basic knowledge of Natural Sciences. The role of this subject in the formation of scientific literacy is important and necessary, as the science of Nature (Biology, Physics, Chemistry and Earth Science) consists of the integration of 3 subjects. Students should have research skills such as evaluating and interpreting scientific research in addition to fundamental knowledge of Natural Sciences in order to be able to explain various phenomena. Science plays an important role in the formation of this competence.

Approbation of research result. The research was carried out at the Department of Theory and Methodology Training in Education Institute of the Republic of Azerbaijan. Articles related to this problem had been presented to the scientific conferences.

Result. The content of this subject, which was taught for the first time in our republic starting from the 2022/2023 academic year, used research-based content and didactic technologies along with integrativeness.

It should be noted that the set of textbooks on the subject of Nature was developed in the 5E* model using the experience of Singapore.

Thus, the main tasks of Natural Science can be summarized as follows:

● to form an inquiry-based learning environment so that students can demonstrate creative and critical approach in solving real-life problems and develop basic skills aimed at making independent decisions and understanding simple patterns between events;

● to play the role of a successful transition between the Life Science subject, which is being improved according to the international experience in Natural Sciences, as well as Biological Science, Physics, Chemistry and Geography subjects, which are planned to be improved, to be taught from the 7th grades.

5E shows the number of initials of the words "engage", "explore", "explain", "elaborate" and "evaluate", which represent the stages of learning in English (Bybee, 2006: 43).

Conclusion. Thus, one of the main contributions that the teaching of the subject "Nature" can make to the Azerbaijani education system is that it will encourage the improvement of the results of our students in the Natural Sciences in international studies such as TIMSS and PISA which are not satisfactory, the reason for this is that students do not have enough knowledge of scientific concepts and laws in Natural Sciences, and they have difficulty answering real-life situational tasks.

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Організація професійної підготовки з викладання предмета "Природа" у закладах середньої освіти

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Основною метою статті є вивчення організації природознавства в компетентнісному навчанні в закладі середньої освіти. В останні роки активна участь нашої республіки в різних науково-дослідних програмах з оцінки досягнень учнів призвела до позитивних змін у підручниковій політиці. У таких програмах (TIMSS та PISA) навички читання, математичної та наукової грамотності учнів вивчаються та оцінюються за допомогою спеціально розроблених інструментів. Слід зазначити, що за результатами останнього дослідження TIMSS, наші здобувачі освіти змогли продемонструвати високі навички математичної грамотності. На жаль, їхні бали з наукової грамотності були нижчими за середній бал з досліджень. Однак формування наукової грамотності в галузі природничих наук надзвичайно важливе у підготовці компетентної молоді майбутнього. У країнах, учні яких показують високі результати за дослідницькими програмами TIMSS та PISA (Сінгапур, Китай, Південна Корея, Фінляндія тощо), формування наукової грамотності у галузі викладання природничих наук є основною метою національної освіти. У статті вивчено спосіб вирішення проблеми формування науково-грамотної компетентності наших учнів на рівні загальної середньої освіти з викладанням інтегративного предмета «Природа», а також обґрунтовано важливість та необхідність вивчення цього предмета. Результати азербайджанських студентів у галузі природничих наук у таких міжнародних дослідженнях незадовільні, причина цього в тому, що студенти не мають достатніх знань наукових понять та законів у природничих науках, і вони не можуть відповісти на питання реального життя, ситуативні завдання.

Важливість застосування: теорію може бути реалізовано в закладах середньої освіти.

Ключові слова: *наукова грамотність, компетентність, природа, TIMSS 2019, PISA 2018, успішність учнів.*

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