Ways for Developing Students' Scientific Literacy Competency in 6th Grade Science Lessons

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Abstract

The Republic of Azerbaijan responds to international challenges in the field of education and continues measures to increase the quality of the content in education, which serves to form vital competencies in students. One of them is the "Reserve textbook" project. In the framework of this project, international experience is studied and a new generation of textbooks is prepared. Among these textbooks, the integrated 5th and 6th grade science textbooks are new for our country. The term science has been adapted to the Azerbaijani language as "nature".

In the VI class "Science" textbook, learning materials are presented in the inquiry-based 5E model.

It should be noted that any stage of the lesson built on the basis of this model creates favorable conditions for the formation of scientific literacy skills in students. In the article, the possibilities of using situational tasks in the formation of scientific literacy in the first stage of this lesson model called "Engage" were investigated. In the process of monitoring the implementation of the textbook "Science 6" in the pilot classes, a short-term written survey consisting of open-type situational tasks was conducted among 241 students at the stage of engaging the lesson. The statistical analysis of the results of the survey revealed that at this stage of the lesson, it is possible to determine the extent of initial knowledge and misconceptions by presenting students with familiar situations from everyday life and natural phenomena while arousing their interest in the subject. In addition, an online survey was conducted among teachers teaching science in pilot classes regarding the effectiveness of science teaching and skill formation, and 81 teachers participated in this survey. As an example, the article provides an analysis of two situational tasks and the results of a survey among teachers.

Keywords: scientific literacy, science education, engagement, situational tasks, 5E

Шляхи формування наукової грамотності учнів на уроках природознавства у 6 класі

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Анотація

Азербайджанська Республіка реагує на міжнародні виклики у сфері освіти та продовжує заходи щодо підвищення якості змісту освіти, що слугує формуванню життєво важливих компетенцій в учнів. Один із них – проект «Резервний підручник». В рамках цього проекту вивчається міжнародний досвід та готується нове покоління підручників. Серед цих підручників є новими для нашої країни інтегровані підручники з природознавства для 5 та 6 класів. Термін наука було адаптовано до азербайджанської мови як «Природа».

У підручнику VI класу "Природа" навчальні матеріали представлені в науково-дослідній моделі 5E. Слід зазначити, що довільний етап уроку з даної моделі створює сприятливі умови на формування в учнів навичок наукової грамотності. У статті досліджено можливості використання ситуаційних завдань для формування наукової грамотності на мотиваційному етапі даної моделі уроку. З цією метою в ході моніторингу в пілотних класах, де застосовується підручник «Природа 6», на мотиваційному етапі уроку серед 241 учнів було проведено короткострокове письмове опитування, яке складається із ситуаційних завдань відкритого типу. Математично-статистичний аналіз результатів опитування виявив, що на цьому етапі уроку можна визначити обсяг вихідних знань і оман, представляючи учням знайомі ситуації з повсякденного життя та явищ природи, одночасно викликаючи в них інтерес до теми. Крім того, серед вчителів, які викладають природничі науки в пілотних класах, було проведено онлайн-опитування щодо ефективності викладання природничих наук та формування навичок, в опитуванні взяли участь 81 учитель. Як приклад у статті наводиться аналіз двох ситуаційних завдань та результати опитування вчителів.

Ключові слова: наукова грамотність, наукова освіта, залучення, ситуаційні завдання, мотиваційний етап

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Introduction.

In order to make the Republic of Azerbaijan a stronger and more stable state, it is implementing reforms that meet global challenges in the field of education as well as in many other fields.

One of these innovations is the development of new-generation textbooks that serve to accelerate integration into international education systems and develop knowledge and skills related to science and technology. During the preparation of new generation textbooks, cooperation with international and prestigious publishing houses is carried out, and framework documents of international research programs on the assessment of student achievements are analyzed in terms of content and structure. Prepared textbook sets (textbook, workbook, and methodical materials) are tested in selected pilot schools for 1-2 years, depending on classes and subjects, before being widely used. The goal here is to further improve the textbook set during the trial period due to monitoring and feedback from teachers and the public. Also, the textbooks in the trial period are shared on the official website, which is open to everyone, where any person can get acquainted with the textbook and write his comments and suggestions. The prepared new-generation textbooks include the Nature 5 and Nature 6 textbook sets.

Formulation of the problem.

The content of Nature 5 and 6 textbooks is based on the 5E model, which has been applied in textbooks of applied subjects (physics, biology, chemistry, and geography) since 2013 in grades 6–9 of the secondary level of general education in our Republic (Murguzov, & Abdurazagov, 2013a; 2013b). This lesson model is a constructive learning theory and consists of organizing training in five consecutive stages (Islamzadeh, 2022, p. 4-5). These are:

1. Engage
2. Explore
3. Explain
4. Elaborate
5. Evaluation (Evaluate) (Bybee, & Landes, 1990).

If we accept that constructivist theory is the best way to describe the learning process, then it is necessary to create learning environments that directly introduce the material being studied to advance students' learning because students experience the world directly. This confirms the idea that constructivist learning takes place in an appropriate constructivist learning environment (Kibici, 2022). Different teaching methods, such as 4E, 5E, and 7E, are used in science teaching to create a constructivist learning environment. The most appreciated and used of these methods is the 5E training method. The constructivist approach was first proposed by Atkin and Karlplus in the 1960s and elaborated in 1997 (Polgampala, Shen, & Huang, 2016).

In the attraction stage, students are presented with qualitative situational questions related to domestic, natural, or technological processes, and the key words of the answers given in the form of hypotheses are recorded without giving an attitude. The purpose here is to establish possible connections between the educational results of the subject studied on the basis of the students' previous knowledge, to arouse interest in the solution of the new educational problem formed in the students, and to provoke them to do research. Such an approach is expected in the nature textbook, not only in the topics but also at the beginning of the each chapter. (Islamzadeh, 2022, p. 4-5).

In the engagement phase, diagnostic assessment of students is also carried out through situational tasks. Thus, as a result of the discussion of situations selected on the basis of the principle of intra-subject and inter-subject integration, the knowledge gained by students is evaluated, and their possible misconceptions are determined. Note that this stage is not intended for the teacher to lecture, define, or explain terms (Duran, & Duran, 2004).

Methods.

Research-based teaching methods have an effective role in the formation of scientific literacy. Research-based learning allows students to think creatively and critically by presenting situations they may encounter in everyday life to students at different stages of the lesson and creating discussions based on questions.

Main part. What is scientific literacy?

The concept of scientific literacy was first developed by Paul De Hbart in the 1950s of the 20th century: "One of the main problems of education is to fill the gaps between the richness of achievements in science and the competence of scientific literacy" (Hurd, 1958; Aghajanli, 2023). Scientific literacy as a concept has been one of the most relevant issues studied by educational researchers in the international sphere since it was introduced into the world of science. Scientific literacy competence requires students to have a certain level of understanding in order to create reliable knowledge about the purpose of scientific research and nature (Aghajanli, 2023; Ziman, 1978). One of the main requirements of the modern era is to train individuals who follow rapid development and have a productive role in social and technological issues. The formation of knowledge and skills on the basics of science and technology and scientific literacy competence in such persons is one of the main factors that create a foundation for the development of countries and societies. The formation of scientific literacy has become the main goal of many educational systems and national curricula. (Roberts, & Bybee, 2014). There is a considerable amount of international research on the formation, development, and assessment of students' scientific literacy competence. The concept of scientific literacy is a widely recognized concept of education and has become the main goal of education (Aghajanli, 2023; De Boer, 2011; Hodson, 2011). In the studies of prestigious international evaluation programs on the

evaluation of student achievements, the weak indicators of scientific literacy of our students are one of the main issues that make the problem of the formation of this competence relevant.

The framework document for science in the PISA research program states that scientific literacy plays an important role as a basic structure for the assessment of acquired knowledge and skills in the fundamentals of the natural sciences. This framework document outlines the content, domain of knowledge, and type of competency reflected in the structure of instruments used to measure scientific literacy.

PISA studies test students' reading, math, and science literacy skills. These are:

- explain events scientifically;
- evaluate and design scientific research;
- interpret data and evidence scientifically (OECD, 2019).

Development of students' scientific literacy through situational tasks.

It is known that the assessment of students' scientific literacy is based on the international PISA program. Scientific literacy is defined as several competencies in the program's science framework document. One of those competencies is "explaining events scientifically". Here, the solution and evaluation of the problems presented on the basis of the integration of natural, technological, social, and household phenomena are envisaged. These problems are presented to the students in the form of both closed and open-ended tasks, and they are required to express the following attitude:

- apply relevant academic and scientific knowledge;
- to make appropriate scientific forecasts, to justify their necessity, and to determine solutions.

Such an approach can be seen in some qualitative tasks presented by PISA:

Why does water evaporate faster on a hot day?

How can the introduction of a new creature into the habitat disrupt this environment?

Give examples of the cases you come across in everyday life where gases can be compressed and liquids cannot be compressed, etc.

In order to solve such simple, open-ended problems, it is necessary to imagine some events, build a description of some, and predict others. For the implementation of this process, the student is required to use academic scientific models (PISA, 2023).

In order to study the students' ability to apply the acquired declarative knowledge to the explanation of familiar situations related to life and the implementation of simple activities they perform in class, we organized a pedagogical experiment during monitoring. A total of 267 students from six schools were involved in the experiment. Of these, 129 students were experimental class students, and 138 students were control class students. The classes were selected in such a way that the same subject teacher taught both the experimental and control classes in the respective schools.

During this experiment, ¬the students of the experimental and control classes were presented with the same tasks on the topics taught to them until that period. The statistical analysis of two tasks with situation content from those tasks is given below. Two open-ended questions were asked in both tasks. The maximum score for the first task was 3, and for the second task it was 6.

Table 1.
General average indicators of students by classes

Schools	The overall average of the students	
	Pilot	Control
Agjabadi 11 №	4.25	1.46
Aghdash 1 №	2.76	1.8
Aghdash Laki 6 №	5.19	2.3
Beylagan 1 №	5.43	1.89
Mingachevir 11 №	4	2.96
Mingachevir 16 №	2.98	2

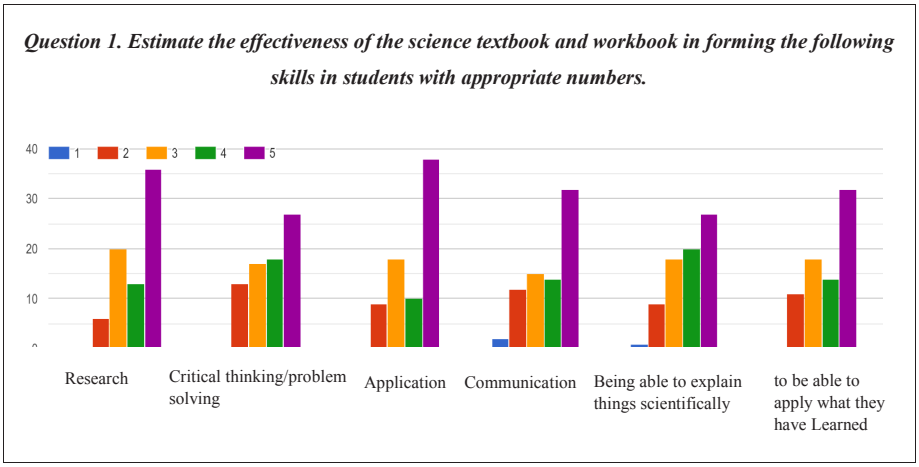
Table 1. shows the general average of students from each school on tasks. It can be seen from the table that the general average indicators of all pilot class students are ahead of the indicators of control class students.

The 5E teaching method was used during the preparation of the 5th and 6th grade nature textbook sets. In the 5th grade, all 5 steps followed in the 5E teaching method were used in the teaching of a chapter rather than in the teaching of a each topic. In the 6th grade, all these five stages were used in the teaching of each topic. Each lesson was divided into five stages.

Physics, biology and life science were taught instead of natural science in the 6th grade control classes. When analyzing the textbooks of these subjects, it can be seen that the 5E stages are used in the textbooks. Based on the obtained results, the control shows that these stages are not properly and effectively organized in the textbooks.

An online survey was conducted among 130 teachers who taught this subject for the first time in pilot schools, whether the implementation of the textbook and workbook on science was effective. 81 teachers participated in the survey. We asked about the effectiveness of the textbook and workbook in the formation and development of the mentioned skills. In the assessment, between 1 and 5, 1 means least and 5 means the most effective. According to the results of the survey, more than half of the teachers said that the textbook set is highly effective in forming research and collaboration skills. More than thirty teachers said that the textbook set is highly effective in

forming the skills of "application" and "communication" of what they have learned. According to teachers, the number of teachers who say that they are highly effective in developing the skills of "critical thinking/problem solving" and "being able to explain things scientifically" is less than other skills.



The fact that the textbook is effective in the formation and development of these skills also shows that it has an important role in the formation of scientific literacy competence.

Structure and content of the engagement phase in the textbook.

Unlike other stages of the lesson, no explanation or evaluation is provided in the stage of emgagement, if it is properly organized, it ensures an effective transition to other stages. Therefore, the correct construction of the first stage is very important for the effective passing of the lesson as a whole. At this stage, providing students with daily familiar situations is a necessary element that was unanimously accepted as mentioned above.

The phase of interest can be given in two different places in the textbook, at the introduction of each chapter and each topic.

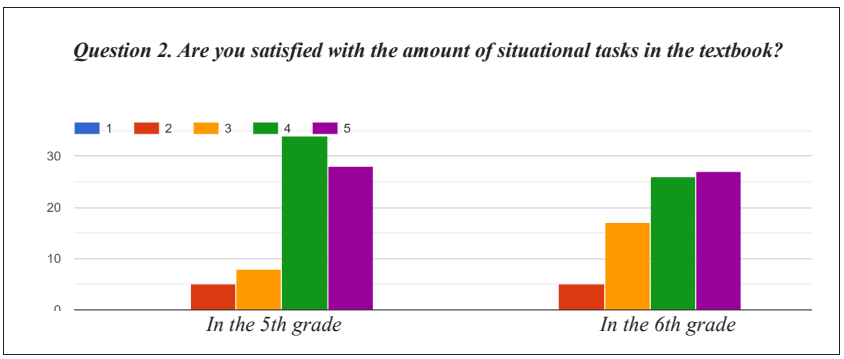
The following requirements can be defined for the situation given on the first page of the chapter:

- The situation should cover the main topic or topics that attract attention to the whole chapter;
- It should cover the historical facts or modern achievements of the science or discipline;
- It should be in a global or national context;
- A picture, text and a few appropriate questions should be given reflecting the situation;
- The section should be concise and clear.

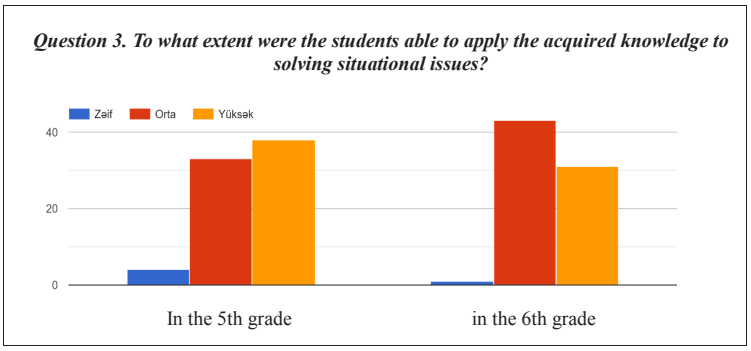
Situational requirements given in the engagement section of the 5E instructional manual:

- It should be related to everyday life;
- It should be in national and individual context;
- The text of the situation should be short and clear;
- It should be able to ensure an effective transition to the next stage;
- It should create more interest in the subject to be studied;
- Asking questions should require reasoning in answering;
- It should allow teachers to identify students' prior knowledge and misconceptions about the subject.

Giving situational tasks related to daily life in other stages of the lesson, not only engaging, plays an effective role in the formation of students' skills. Therefore, in the survey we conducted among teachers, we asked to what extent they were satisfied with the amount of sitiasuya tasks in the textbook. As can be seen from the diagram, when evaluating 5th grade textbooks, teachers mostly chose 4 and 5, which indicates that there are enough situational tasks, although not to a high degree. In the 6th grade, teachers mostly chose 3, 4 and 5 when evaluating. According to the opinions of the teachers, it can be said that in the textbook of the 6th grade, the situation tasks were given less attention to the 5th grade.



We asked to what extent the students were able to apply their knowledge in solving the situational tasks given in the textbook. The answers given by the teachers in question 3 show that they were able to apply the knowledge gained by students in the 5th grade to the solution of situational tasks at an average and high level, and in the 6th grade more at an average level As can be seen from the teachers' answers to the 1st question, the textbook set is moderately, if not highly, effective in forming the ability to apply what they have learned as many skills. There can be various reasons why students have difficulty in solving situational tasks, such as difficulty in understanding what they read, and their tendency to memorize because they are used to the test method . These mentioned reasons create fundamental obstacles for students to freely and creatively express their opinions on the problems and propose solutions.



The role and importance of situational tasks at the stage of interest.

The situation in the stage of curiosity given in the introduction of the topic should be related to everyday life. It is important to understand what is meant by daily life. Daily life in the teaching of natural science does not mean everyday activities at school. Everyday life in nature classrooms is more of something outside the classroom. Science needs to be connected to someone's everyday life in the real world, a world without school (Andrée, 2005).

When students are presented with familiar situations in the engagement stage, they are very interested, and because they do not think about the regularity between the events in the situation in advance, or in some cases, they cannot find an answer, the current situation focuses them completely on the discussion of questions.

Presenting interest to students using familiar situations is the main element of concentration and increase of students' continuous interest and attention to learning (Upadyaya, 2021).

Approbation of research results.

The main provisions of the article are reflected in the author's theses submitted to scientific conferenes in Azerbaijan and in abroad.

Conclusions.

It can be applied to middle school science and other subject textbooks. In the engage phase of textbooks prepared with the 5E teaching method, giving situational tasks related to daily life plays an effective role in developing students' critical thinking, applying what they have learned, problem solving, and scientific literacy.

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