

## DEVELOPMENT OF FUNCTIONAL LITERACY AMONG STUDENTS IN PREPARATION FOR INTELLECTUAL COMPETITIONS IN BIOLOGY

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### **Summary**

*The issue of schoolchildren's functional literacy development is the main topic of the study, which is based on pedagogical literature. Analysis and testing are done on the outcomes of students both before and after the application of test tasks influencing the development of functional literacy in schoolchildren. The following characteristics of how these tasks affected the intellectual kids in two classes are taken into consideration: 8 and 10 In order to be prepared for the intellectual competitions in biology, it is found that complicated tasks have an impact on the growth of functional literacy. The style of inquiry was used with pupils between the ages of 14 and 16. The level of FL students was found to be impacted by tasks for the development of functional literacy.*

**Key words:** *FFL – functional literature, biology, intellectual competitions.*

**Introduction.** "Understanding, assessing, and using written materials and engaging with them to participate in society, attain one's goals, and develop one's knowledge and potential" is the definition of literacy [1,15 p]. Biology is a fundamental and applied science field that is rapidly growing. It is crucial to our understanding of life at all scales, from molecular biology to interactions on a global scale [2,35-47 pp].

The ability to function in the social roles of a voter, consumer, family member, and student is determined by functional literacy. It enables you to put your abilities to use in setting up various adventures, creating

connections with various social structures and organizations, etc [3, 206–238 pp].

PISA understands functional literacy in a broad sense as a set of knowledge and skills that ensure the successful social and economic development of the country; [4] in a narrow sense, as the key knowledge and skills necessary for a citizen to fully participate in the life of modern society [5].

A person's capacity to answer questions about the natural sciences, as well as their preparedness to have a keen interest in scientific concepts, developments, and innovations [6, 52-75pp.]. PISA includes a set of specified competencies for science literacy. The ability of pupils to use the knowledge and abilities they have learned in school in real-world settings is referred to as competence [7, 224-263 pp.].

In PISA, there are three main categories of tasks:

1. "How do you know?" tasks that require the use of ways of knowledge [13, 577-598 pp.].
2. Assignments to "try to explain" events and facts [14, 30 p.].
3. "Make a conclusion" assignments help students develop the ability to draw conclusions based on data [15, 319-340 pp.].

People who are biologically literate should comprehend the fundamental ideas in biology [8, 607-627pp.]. Students that are biologically literate should understand the variety of species and how they are categorized [9]. The fundamental ideas of biology should be understood by all citizens. Memory, analysis, comprehension,

learning, and reasoning are only a few examples of cognitive skills [10, 93-107].

"Developing functional literacy toolkits for middle and high school students in biology" is intended to: promote the development of a range of skills and abilities that are at the core of functional competence [11, 1459-1482 pp.].

The developed set of tasks is a tool for developing specific skills, which together constitute biology as a subject and the essence of functional abilities. Possession of these abilities and skills serves as an indicator of FG base in students while preparing for biology intellectual competitions [12, 59-78 pp.].



**Materials and research methodologies.** in Pavlodar city's Nazarbayev Intellectual in Pavlodar city's Nazarbayev Intellectual School of Chemistry and Biology, experimental work was done. For this project, tasks (40–50) were created using PISA examples at various levels to help students get ready for biology-related academic competitions. The trial involved

44 students from the 8th (24) and 10th (20) classes (24 guys, 20 girls). The group's ages ranged from 14 to 17. The questionnaire was distributed in Google style and included 14 questions.

The scientific novelty of this work is that testing tasks should correspond to different levels of FL mastery, which contributes to student development while taking into account unique student characteristics in preparation for PISA, various Olympiads, etc. The development of knowledge, in our case the development of FG students, is most effective when carried out methodically, with a variety of types and forms.



**Applied in biology innovative methods and techniques.** These biology tasks include 25 complex tasks based on the example of PISA tasks. The questions are created in accordance with basic biological principles. The focus of the tasks on the organization of functional literacy includes topics on botany, zoology, genetics, physiology, ecology, immunology, microbiology and general biology (Table 1).

Table 1. Tasks for developing functional literacy in preparation for biology intellectual competitions

<p><b>Task № 17.</b> The picture shows a spider and a pin standing in water.</p>  <p><a href="https://celes.club/uploads/posts/2021-11/1637087955_40-celes-club-p-serebryanka-nasekomoie-nasekomie-krasivo-to-47.jpg">https://celes.club/uploads/posts/2021-11/1637087955_40-celes-club-p-serebryanka-nasekomoie-nasekomie-krasivo-to-47.jpg</a> <a href="https://www.pmtcourses.com/wp-content/uploads/2020/09/physics-surface-tension.jpg">https://www.pmtcourses.com/wp-content/uploads/2020/09/physics-surface-tension.jpg</a></p> <p><i>Question 17.1. What do a spider floating in water and an iron pin have in common?</i></p>  <p><a href="https://avatars.mds.yandex.net?id=76e201ccc2d37329d266affa4f2a59ac_1-5289481-images-thumbs&amp;n=13">https://avatars.mds.yandex.net?id=76e201ccc2d37329d266affa4f2a59ac_1-5289481-images-thumbs&amp;n=13</a></p>	<p><b>Task № 17.</b> <i>Question 17.1</i> The reason spiders float in water is the presence of hairs that cause the spider to be weightless. Because the pin is lightweight floats in water. <i>Question 17.2.</i> 1. Pedipals 2. Fangs 3. Chelicerae 4. Eyes 5. Legs 6. Spinnerets 7. Abdomen 8. Pedicel 9. Cephalothorax</p>
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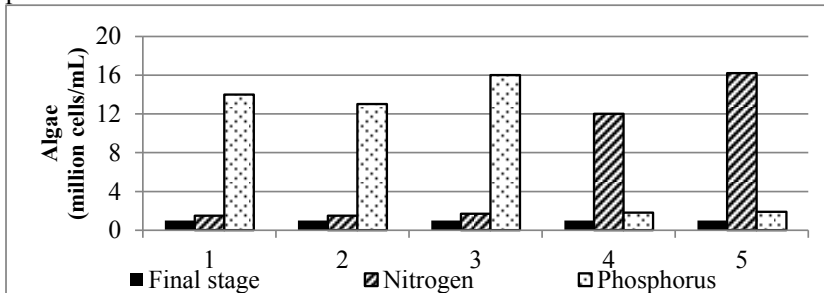
<i>Question 17.2. Identify the structure of the spider in the picture.</i>	
<b>Task № 19.</b> Evolution The evolution of sexual reproduction is still a mystery in some respects. Over the years, many hypotheses have been put forward to explain these phenomena.	<b>Task № 19.</b> <i>Question 19.1.</i> 1. F

Continuation of table 1

<i>Question 19.1. State whether each of the following concepts is a TRUE or FALSE:</i>		2. T 3. F 4. F
<b>№</b>	<b>APPROVALS</b>	<b>T/F</b>
1	The effect of sexual reproduction on the association between alleles is expected to improve the adaptability of the united genes.	
2	Given that many mutations are bad for sex in small populations, the loss of individuals without mutations is contraindicated.	
3	Preventing inbreeding in sexually reproducing organisms is expected to be beneficial when harmful mutations predominate.	
4	Stable regions can be expected to have a higher proportion of sexually reproducing species than unstable regions.	
<i>Question 19.2. Why have abortions increased nowadays, the main reason?</i> <i>Question 19.3. What causes might lead to mutations?</i>		<i>Question 19.2.</i> Fully disclose and communicate your message. <i>Question 19.3.</i> Fully disclose and communicate his/her message.
<b>Task №21.</b> A student found two different leaves of different plants. He took it with him and then noticed that it had started to rot. They are shown in picture A and B.		<b>Task №21.</b> <i>Question 21.1.</i> A – Dicotyledonous (leaf) B – Monocotyledonous (leaf)
 <a href="https://freepngimg.com/thumb/green%20lves/65-green-leaf-png.png">https://freepngimg.com/thumb/green%20lves/65-green-leaf-png.png</a> <b>A</b>	 <a href="https://upload.wikimedia.org/wikipedia/">https://upload.wikimedia.org/wikipedia/</a> <b>B</b>	<i>Question 21.2.</i> Fungi <i>Question 21.3.</i> Leaves are decomposed with the help of decomposers; Nitrogen in the form of ammonia (returns to the soil); Ammonia is converted into nitrates by bacteria in the soil;
<i>Question 21.1. Identify to which two main groups the leaves shown in the picture belong.</i> <i>Question 21.2. The process of putrefaction is most often caused by bacteria. Name one other organism that can prevent decay.</i> <i>Question 21.3. Leaf rotting improves the composition of the soil and creates conditions for good plant growth. Explain how the process of rotting returns nitrogen to the soil.</i>		

<p><b>Task №22.</b> The photo shows the skeleton of the Gorilla beringei gorilla and the human skeleton of Homo sapiens.</p>	<p><b>Task №22.</b> <i>Question 22.1.</i> Two-legged. <i>Question 22.2.</i> Altered hip bone shape; altered spine/thin neck; short arms (in proportion to</p>
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Continuation of table 1

<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p><a href="https://avatars.dzeninfra.ru/get-zen_brief/">https://avatars.dzeninfra.ru/get-zen_brief/</a></p> <p><b>A</b></p> </div> <div style="text-align: center;">  <p><a href="https://avatars.dzeninfra.ru/get-zen_doc/4944693/">https://avatars.dzeninfra.ru/get-zen_doc/4944693/</a></p> <p><b>B</b></p> </div> </div> <p><i>Question 22.1. Humans are thought to be descended from animals such as gorillas, as shown in Figure A. Humans walk on two legs. What is this movement called?</i></p> <p><i>Question 22.2. Describe two ways in which the skeleton in picture B adapted to this type of movement.</i></p> <p><i>Question 22.3. Mention one advantage of Homo sapiens associated with vertical walking.</i></p>	<p>legs); altered skull shape; <i>Question 22.3.</i> Vision is well developed; Transport/holding, heavy load/tools/children( light); fast running;</p>
<p><b>Task № 9. Experiment with algae..</b> Scientists have studied the effects of adding nutrients to US east coast waters. The graph shows additional nutrients added and algae produced at six locations. No nutrients were added during the most recent period.</p>  <p><i>Question 9.1. where was the greatest algae growth observed when the phosphorus nutrient was added to the response?</i></p> <p><i>Question 9.2. where was the phosphorus supply sufficient before the experiment?</i></p> <p><i>Question 9.3. in which locations was nitrogen the factor limiting algae growth?</i></p> <p><i>Question 9.4. in which of the following macromolecules in the algae's environment are nitrogen and phosphorus compounds added?</i></p> <p>I. Carbohydrates II. DNA III. Protein</p>	<p><b>Task № 9.</b> <i>Question 9.1.</i> C. 3 <i>Question 9.2.</i> C. 1, 2 және 3 <i>Question 9.3.</i> C. 1, 2 және 3 <i>Question 9.4.</i> D. II және III</p>

Therefore, 25 complex tasks are compiled on topics such as botany, zoology, genetics, physiology, ecology, immunology, microbiology and general biology, etc. The questions are created in accordance with basic biological principles. The focus of the tasks on the organization of biological literacy.

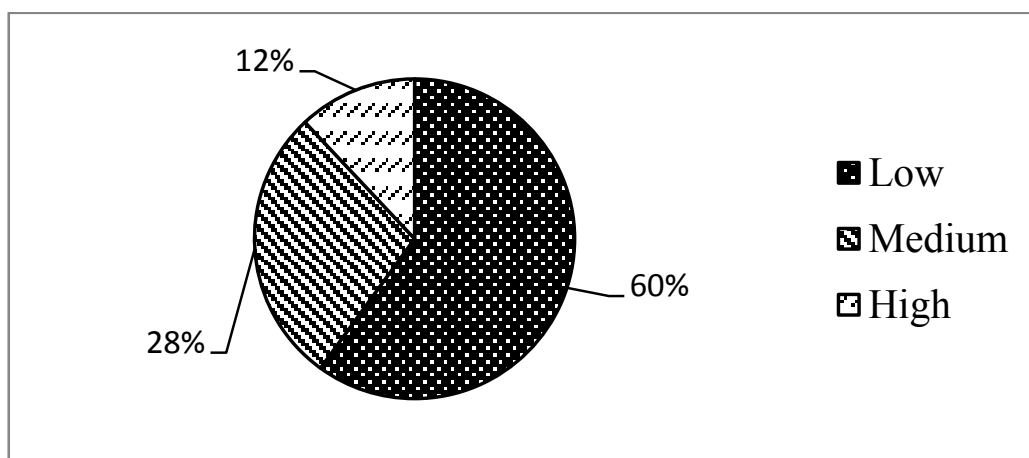
**Results and discussion.** A Google forms questionnaire was administered, which consisted of 14 questions. The first questions included personal data (postal address, name, surname, age, class), followed by questions about the motivation for learning and the core of the survey was a question about the level of learners' knowledge of FL (Picture 1).

Picture 1. Structure of nephron – Google forms questionnaire

At the ascertaining stage, the goal of the pedagogical experiment was to assess the degree of functional literacy and try to improve it.

Following the conclusion of the educational experiment, we may track

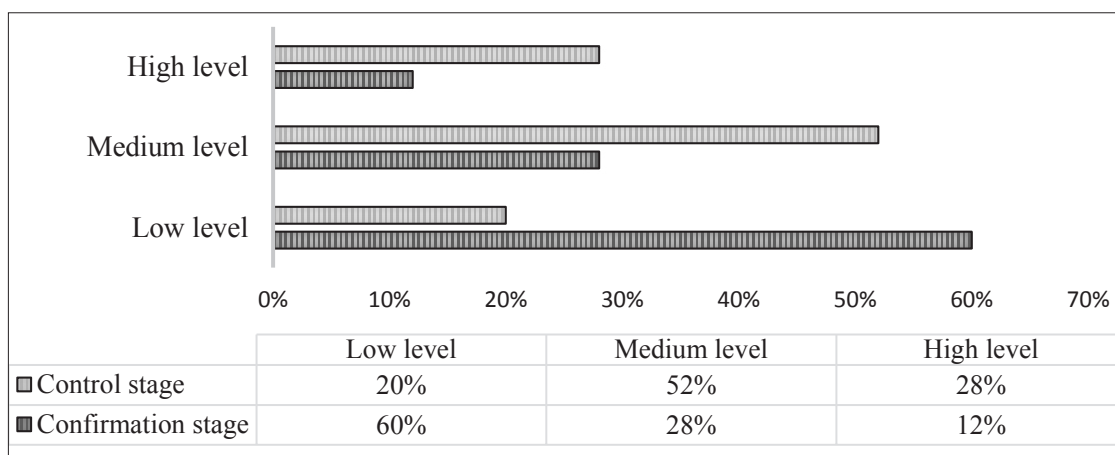
changes in the ratio of the number of students and functional literacy in the subject "biology" in the control and experimental groups by comparing the results from the two questionnaires. Let's illustrate these findings with a diagram (Picture 2).



Picture 2. Overall level of theoretical knowledge of students to determine the FG of biology learners

After implementation of complex tasks an increase in FL is observed as compared to the constant period in the control period of the experiment. The increase in the level of knowledge in "biology" in the control period is explained by the application of special tasks to the subject under study, affecting the development of FL (Figure 3).

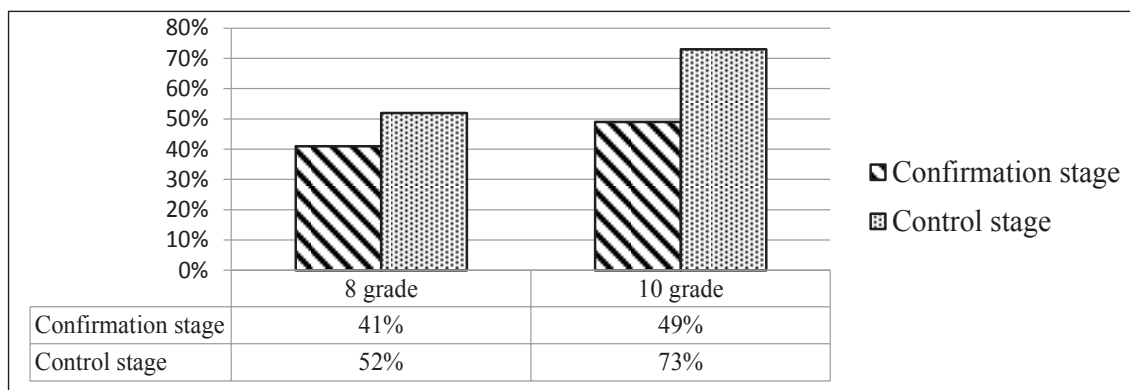
It is important to note that the low level of FG in biology is present in 60% of children, or 26 individuals, and is 32% lower than the average level. The average potential for intellectual competitions is 30% of all responders. Furthermore, just 5 respondents, or 12% of the total, are highly intelligent. (Picture 3).



Picture 3. Number of students (in %), level of FG in the subject "biology" at the ascertaining and controlling stages of the experiment

The graphic demonstrates that there is a noticeable rise in the number of students who demonstrate the ability to apply their knowledge in the experimental group as compared to the control group. According to the data, there was a 24% rise in the number of students who displayed an average level in the control stage by the

end of the educational experiment, and there was a 16% increase in the number of students who demonstrated a high level throughout the diagnostic work, of FG. Accordingly, 40% fewer students in the control stage displayed poor levels of proficiency (Picture 4).



Picture 4. Comparative scores of students in grades 8 and 10 in the pilot and control phases of the experiment

In the pilot stage, if we compare classes according to these parameters, the 8th grade (41%) demonstrated a low level compared to the 10th grade (49%). If we compare these classes' control stages in percentage terms, the 8th grade showed an increase of 11%, while the 10th grade showed an increase of 24%.

Conclusion. Overall, the findings from the diagnostic tests used to determine a student's functional grammar (FG) and, in many cases, their ability to use it, can be used as convincing proof of the success of the activities created to help students get ready for biology-related intellectual competitions.

During the experiment, the level of functional literacy of students in grade 8 increased from 41% to 52% and in grade 10 from 49% to 73%. Considered as a percentage, there was an increase of 11% in grade 8 and 24% in grade 10.

The research undertaken in this work does not exhaust the whole content of the problem of functional literacy development in the process of preparation for biology intellectual competitions and opens up prospects for further research. The topic of this work seems promising, as the proposed new set of tasks can be adapted and similarly applied to the content of other sections of the school biology course.

#### List of abbreviations

PISA – Programme for International Student Assessment.

FL – Functional literacy.

#### References

1. T. Scott Murray, *Functional literacy and numeracy: Definitions and options for measurement for the SDG Target- UNESCO Institute for Education, Hamburg* -2017. -P. 15.
2. Duncan, G. R., Boerwinkel, J. D. *Molecular biology. In K. Kampourakis, M. J., Reiss (Eds.), Teaching biology in school: Global research, issues, and trends* .2018. -P. 35–47.
3. Post, A., Semilariski, H., & Laius, A. *Assessing the biological literacy cognitive components of 10th and 11th grade students. Estonian Journal of Education*5(1), Estonia. -2017. -P. 206–238.
4. *PISA 2015 Results. Excellence and Equity in Education. Volume 1.* URL: <https://www.oecd-ilibrary.org/>
5. *PISA 2016 Results. Excellence and Equity in Education. Volume 1.* URL: <https://www.oecd-ilibrary.org/>
6. Uttamchandani S. *Educational intimacy: Learning, prefiguration, and relationships in an LGBTQ youth group's advocacy effort. Journal of the Learning Sciences*,30(1). -2021. -P. 52-75.
7. Harris E.M., Dixon C.G.H., Bird E.B., Ballard H.L., *For Science and Self: Youth Interactions with Data in Community and Citizen Science, Journal of the Learning Sciences*, 29(2). -2020. -P. 224-263.
8. F., Pachman M., Dai Z., *Investigating educational affordances of virtual reality for simulation-based teaching training with graduate teaching assistants, Journal of Computing in Higher Education*,32(3). -2020. -P. 607-627.
9. Schumacher C., Ifenthaler D., *The importance of students' motivational dispositions for designing learning analytics, Journal of Computing in Higher Education*,30(3). -2018. -P. 599-619.
10. Fischer J., Jansen T., Moller J., Harms U. *Measuring biology trainee teachers' professional knowledge about evolution—introducing the Student Inventory, Evolution: Education and Outreach*,14(1). -2021. -P. 93-107.
11. Quilez J., *Supporting Spanish 11th grade students to make scientific writing when learning chemistry in English: the case of logical connectives, International Journal of Science Education*, 43(9). -2021. -P. 1459-1482.
12. Jacob M., Iannelli C., Duta A., Smyth E., *Secondary school subjects and gendered STEM enrollment in higher education in Germany, Ireland,*

and Scotland, *International Journal of Comparative Sociology*, 61(1). -2020. -P. 59-78.

13. Miedijensky S., Sasson I., Yehuda I., *Teachers' Learning Communities for Developing High Order Thinking Skills—A Case Study of a School Pedagogical Change*, *Interchange*, 52(4), -2021. -P. 577-598.

14. Marin-Marin J.-A., Moreno-Guerrero A.-J., Duo-Terron P., Lopez-Belmonte J., *STEAM in education: a bibliometric analysis of performance and co-words in Web of Science*, *International Journal of STEM Education*, 8(1). -2021. -P. 30.

15. Rudyshyn S.D., Stakhova I.A., Sharata N.H., Berezovska T.V., Kravchenko T.P., *The effects of using a case study method for environmental education*, *International Journal of Learning, Teaching and Educational Research*, 20(6). -2021. -P. 319-340.

#### Список использованных источников

1. Т. Скотт Мюррей, *Функциональная грамотность и умение считать: определения и варианты измерения для целей ЦУР - Институт образования ЮНЕСКО, Гамбург -2017. - С. 15.*

2. Дункан Г. Р., Бурвинкель Дж. Д. Молекулярная биология. В К. Катроуракис, М. J., Reiss (ред.), *Преподавание биологии в школе: глобальные исследования, проблемы и тенденции.2018. -С. 35–47.*

3. Пост, А., Семиларски, Х., и Лайус, А. Оценка когнитивных компонентов биологической грамотности учащихся 10-х и 11-х классов. *Эстонский журнал образования*5(1), Эстония. -2017. -С. 206–238.

4. Результаты PISA за 2015 год. *Совершенство и равенство в образовании. Том 1.* URL: <https://www.oecd-ilibrary.org/>

5. Результаты PISA за 2016 год. *Совершенство и равенство в образовании. Том 1.* URL: <https://www.oecd-ilibrary.org/>

6. Уттамчандани С., *Образовательная близость: обучение, преобразование и отношения в пропагандистских усилиях молодежной группы ЛГБТК.* *Журнал обучающихся наук*, 30(1). -2021. -С. 52–75.

7. Харрис Э.М., Диксон К.Г.Х., Берд Э.Б., Баллард Х.Л. *За науку и себя: взаимодействие молодежи с данными в сообществе и гражданской науке*, *Журнал обучающихся наук*, 29 (2). -2020. -С. 224–263.

8. Ф., Пачман М., Дай З., *Исследование образовательных возможностей виртуальной реальности для обучения на основе моделирования с ассистентами-выпускниками*, *Журнал вычислительной техники в высшем образовании*, 32 (3). -2020. -С. 607–627.

9. Шумахер С., Ифенталер Д., *Важность мотивационных установок студентов для разработки аналитики обучения*, *Журнал вычислительной техники в высшем образовании*, 30 (3). -2018. -С. 599–619.

10. Фишер Дж., Янсен Т., Моллер Дж., Хармс У. *Измерение профессиональных знаний учителей—практикантов биологии об эволюции - введение в инвентаризацию учащихся*, *Эволюция: образование и аутизм*, 14 (1). -2021. -С. 93–107.

11. Квилес Дж., *Поддержка испанских учащихся 11-го класса в написании научных статей при изучении химии на английском языке: пример логических связей*, *Международный журнал научного образования*, 43 (9). -2021. -С. 1459–1482.

12. Джейкоб М., Яннелли С., Дута А., Смит Э., *Предметы средней школы и гендерный охват STEM высшим образованием в Германии, Ирландии и Шотландии*, *Международный журнал срав-*



нительной социологии, 61 (1). -2020. -С. 59–78.

13. Медиженский С., Сассон И., Иегуда И., Учебные сообщества учителей для развития навыков мышления высокого порядка — Тематическое исследование школьных педагогических изменений, *Interchange*, 52 (4), -2021. -С. 577–598.

14. Марин-Марин Дж.-А., Морено-Герреро А.-Дж., Дуо-Террон П., Лопес-Бельмонте Дж., STEAM в образовании: библиометрический анализ производительности и сопутствующих слов в *Web of Science*, *Международный журнал STEM-образования*, 8(1). -2021. -С. 30.

15. Рудышин С.Д., Стахова И. А., Шарата Н.Х., Березовская Т. В., Кравченко Т. П., Эффекты использования метода тематических исследований для экологического образования, *Международный журнал обучения, Teaching and Educational Research*, 20(6). -2021. -С. 319–340.

**Развитие функциональной грамотности у учащихся в процессе подготовки к интеллектуальным конкурсам по биологии**

**Аннотация**

Проблема развития функциональной грамотности школьников является основной темой исследования, которое основано на педагогической литературе. Анализ и тестирование результатов учащихся проводятся как до, так и после применения тестовых заданий, влияющих на развитие функциональной грамотности у школьников. Приняты во внимание следующие характеристики того, как эти задания повлияли на учеников двух классов: 8 и 10, чтобы подготовиться к интеллектуальным конкурсам по биологии, установлено, что комплекс заданий оказывают влияние на рост функциональной грамот-

ности. Проведен метод анкетирования с учениками в возрасте от 14 до 16 лет. Было обнаружено, что на уровень ФГ студентов влияют задания по развитию функциональной грамотности.

**Ключевые слова:** функциональная грамотность, биология, интеллектуальные соревнования.

**Биология пәні бойынша зияткерлік конкурстарға дайындық процесінде оқушылардың функционалдық сауаттылығын дамыту**

**Аңдатпа**

Оқушылардың функционалдық сауаттылығын дамыту мәселесі педагогикалық әдебиеттерге негізделген зерттеудің негізгі тақырыбы болып табылады. Оқушылардың нәтижелерін талдау және тестілеу арқылы оқушылардың функционалдық сауаттылығын дамытуға әсер ететін тест тапсырмаларын қолданғанға дейін және қолданғаннан кейін де жүргізіледі. Тапсырмалар тобы әзірленіп, 8 және 10 сыныптарға функционалдық сауаттылықтың өсуіне әсер ететіні дәлелденді. Сауалнама әдісі 14 пен 16 жас аралығындағы оқушыларға қолданылды. Оқушылардың білім (функционалды сауаттылық) деңгейіне функционалдық сауаттылықты дамытуға арналған тапсырмалар әсер ететіні анықталды.

**Түйінді сөздер:** функционалды сауаттылық, биология, зияткерлік жарыстар.

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