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Didactic Conditions for the Organization of Self-study and Self-Assessment of Students in the Study of Biology

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Abstract

Organizing self-study is essential during the COVID-19 pandemic. Many teachers and students are faced with the problems of remote learning of educational material. Therefore, it is advisable to create and highlight those methods that will facilitate the study of biology. The purpose of this research was to develop approaches, in which students are motivated for self-study and self-assessment with minimal teacher guidance. Schools were selected randomly for the study. Each of them had 4 cohorts per course. In such a cohort, three experimental groups and one control group were randomly selected. One experimental group was given both success criteria and a checklist, another experimental group was given success criteria, and a third experimental group was given a checklist. As a result of the research, it can be seen that the method of teaching the material, as well as the means, affect the success criteria. The use of different methods of self-assessment in the learning process increases the knowledge and motivation of students to study biology. For example, after testing, the students were allowed to independently check their work and analyze their mistakes, or use different colors to highlight those tasks that the student wrote himself (the answer is correct), those with errors and those, with which difficulties arose. In addition, one can improve their communication skills and bonding with their classmates by helping others check their work. The findings will help teachers and other educators meet the educational challenges of the twenty-first century.

Keywords: control, remote learning, interactive methods, motivation, checklist

INTRODUCTION

The situation with COVID-19 showed the problems that the educational system faces. Firstly, this is the lack of necessary educational material, including interactive methods. Secondly, most students and schoolchildren have insufficiently developed self-study and self-assessment skills (Pocsova et al., 2021). Both in developing and developed countries, students cannot obtain high-quality knowledge, since the importance of students is not noted and study control is not created during online lessons. Therefore, during the pandemic, many parents were worried about their children and their level of knowledge. The study will focus on ways to improve didactic skills through success criteria and checklists while learning in the Google classroom. Also, great attention should be paid to the correct use of didactic materials, which will improve the motivation of students and facilitate the study of biology. Recent PISA (Programme for International Student Assessment) estimates for Kazakhstan also indicate that tuition will drop by eight PISA points as a result of the pandemic. PISA is a study of an international student assessment program that looks at the math, reading, and science skills of 15-year-olds (Marteau, 2020).

In their research, P. Angriani and H. Nurcahyo (2019) showed the importance of using various online systems that help to increase the level of knowledge and self-assessment of students. They characterized Moodle. The research results showed that the media verification score amounted to about 3.85 points (very good), and the material verification score was 3.8 points. In other words, one can see a positive impact on students' motivation to learn, ease of self-assessment when using this program. G. Orluwene and R. Ekom Dick Ekim (2020) conducted research on the effectiveness of self-assessment among students who study in Rivers State, Nigeria. The research results showed that the use of the self-assessment method and the complex peer assessment method were effective in promoting self-directed learning, while the teacher assessment method worsened learning. K. Kadriye and E.I. Sonmez (2021) came to the conclusion that the use of laboratory practices with biology in the learning process, which are supported by self-directed strategies, allows students to develop skills for self-study. The research results were formed on the basis of an experiment with 2 groups using the “Scale of readiness for self-study”.

An article by A. Dadjari et al. (2020) describes the use of the flipped activity method. As a result of the research, it was shown that this method has a positive impact on the independent work of students (the self-analysis method was carried out using the Fisher self-assessment questionnaire). For example, in their article, T.E.T. van Woezik et al. (2021) described the possibility of developing a student's independent work while working in a team. As a result, it was found that emotional attitude is of great importance in teamwork and when developing self-control. Therefore, it is important to create common methods and tasks in the learning process.

Therefore, the purpose of this research is to develop approaches, in which students are motivated to self-study and self-assessment with minimal teacher guidance. During the research, the following tasks were highlighted: to develop students who have self-motivation for self-study and self-assessment, to develop learning models that will improve self-study and self-assessment of students.

Clarity about the purpose of self-assessment and self-study allows students to take control of their actions and improve academic knowledge. G.T.L. Brown and L.R. Harris (2013) indicated that self-assessment helps students develop agency in learning and assessment processes. It encourages students to engage in self-directed learning and acts as an invaluable source of timely student feedback that supports improvements. E. Panadero et al. (2017) summarized five different taxonomies of self-assessment and called for the development of a comprehensive typology considering, among other things, its purpose, presence or absence of criteria, and method. In response, it is recommended to establish success criteria and checklists to help students work independently. However, self-assessment of standards is preferred, as are similar studies by E. Panadero et al. It is necessary to engage students in self-assessment when discussing biological mechanisms, genetic problems, or environmental issues using checklists with criteria.

Self-study is one of the most important skills that students need to develop: homework, projects, and other tasks that require students to study independently. Self-study, according to P. Hollins and N. Whitton (2008), is not only about improving results in the classroom or office. It's about being able to take your life in any direction you choose and overcoming obstacles in front of you. The article by S.B. Akhmedova et al. (2022) describes the methods and forms of self-directed study of biology by students. This study was conducted on the example of studying the wheat family and included practical tasks, a demonstration lecture, the use of a computer and work with a textbook. In the system of self-assessment, great attention is paid to the use of a rating assessment system, which helps students determine the level of knowledge among all students. The practical significance of this method was described by I.R. Pavlova (2006). The use of the soft skills methodology, which is based on the development of the right hemisphere of the brain, has a positive impact on the self-study of students. In the course of studying the topic “Human and their health”, this method was used and characterized by V.E. Khachaturyants and A.V. Teremov (2021).

In order to increase the level of self-study in biology, much attention should be paid to the motivational component. This is described in detail in the article by A.O. Tishchenko (2010) who considered the use of information technology in remote learning. This question was also described by K.V. Khaibulina (2012), and the use of e-learning was described by N. Polyakova (2010). To improve the level of self-study and self-assessment, according to N.G. Lipkina and O.R. Pechkina (2020), students should be accompanied by a tutor. The formation of research competence in the process of studying biology in students was studied by N.Z. Smirnova and O.V. Berezhnaya (2014). The use of laboratory work in biology classes contributes to the development of skills to independently analyze and compare the objects under study. The method of their use is described in the article by R.Sh. Izbasarova and L. Zhylkaidarova (2016). The role of self-directed work has been explored by R.Sh. Izbasarova and K. Turgynbai (2016). They identified the key components of self-directed work.

To improve self-study, it is important to develop logical thinking regarding many biological processes. This topic is covered in the article by M.A. Jakunchev and A.I. Kiseleva (2014). M.A. Magomedova et al. (2017) studied the use of interactive methods in the process of self-actualization of schoolchildren. The formation of self-

assessment skills in secondary school students was described in detail by I.S. Sinitsyn et al. (2016), and self-directed knowledge formation with the help of texts was studied by M. Kramer et al. (2021), while Y. Choi et al. (2017) explored the impact of "active learning" on improving self-study. Information was used from these sources that helped to form a methodology, as well as highlight the most productive methods used in the process of self-assessment and self-study by students.

METHODS

The research was conducted with students in grades 9-11 in the biology subject. In total, about 200 students were studied at the Nazarbayev Intellectual School of Chemistry and Biology in Kyzylorda. Regarding the sampling strategy, schools were randomly selected to minimize bias, since each school had four cohorts per course. Three experimental groups and one control group are randomly selected in each of them (each group has an average of 30 students). One of the experimental groups was given both success criteria and a checklist. The other experimental group was presented only with the success criteria, while the fourth experimental group had no innovations and was trained without changes using traditional methods. The research used the same biology curriculum (unchanged) and the same teachers who taught the children before the experiment. This was done in order to exclude the influence of new teachers on the work of students. In addition, the study was conducted in the same period of study and in the same age group, so that there was no strong influence on the psycho-emotional state of students.

Regarding the research, each cohort used its own study methods: the first group used success criteria and a checklist as independent variables, the second group provided only success criteria, the third group used checklists. The fourth group was used as a control group without success criteria or checklists. The performance level for each group depended on the type of material and method. Teachers and resources remained constant, with no shifts. In addition to this research, the university requested permission from principals of two schools to collect data from students. Also, consent forms were prepared, which were signed by the parents of the students in the study group, since most of the students are minors. A pre-study was conducted before and after the study, using a survey of students from these two schools through the Google Classroom, and then student performance was tracked as a dependent method.

Also, during the research, primary and secondary data were collected using a mixed approach. On their basis, tables (showing the academic knowledge of students), histograms for interpreting the results and charts of results were created, and a two-tailed t-test was used to scientifically compare the results of all four groups (three experimental and one control). In addition, the research analyzed the materials that were used in the course of self-assessment of students. These included laboratory work, assignments for determining the correct answer and marking them with the appropriate color; testing students' knowledge by their peers. An important point in the research was that maximum attention was paid to the processes of self-study and self-assessment, taking the gender of the students into account. This helped to find out whether the gender of the students has an

impact on the interest in studying biology and whether this, in turn, affects the processes.

RESULTS

Teachers and educators in educational institutions have reported backlash from students prior to the COVID-19 pandemic, which has been well documented in developed and non-developing countries. The impact of success criteria and checklists on primary school children (ages 15-18) studying biology in grades 9-11 is poorly studied. The purpose of this research was to report on changes in performance across populations through the use of success criteria and checklists. The research scope is limited to 200 student volunteers; 100 students of each gender aged 15-18 who were contacted by their school principals through their Google accounts. This recruitment period lasted three months and ended when 200 volunteers were recruited. Each volunteer participating in the research was asked to complete a pre-briefing session, attend a Google Classroom briefing, and be assessed after the briefing to evaluate any changes that the success criteria and checklist have made to their academic performance in their chosen biology topics. In accordance with the updated education system, self-study and self-assessment skills are important for deeper independent understanding of new knowledge, quick familiarization with scientific discoveries, self-development, self-assessment, as well as assessment of others. However, the emphasis on self-directed learning these days makes it much more difficult for students with a low level of education to form a positive social identity. Students are able to quickly adapt to difficult situations, such as various pandemics in society, and be ready for self-study and self-assessment in the effective implementation of professional activities (Figure 1).

The use of information technology improves the educational process and cognitive activity of students during the study of biology. An important point is the use of self-directed work, which allows to develop the ability to analyze and logically choose the right answer. When conducting self-directed work, one can use different areas, for example, wildlife corners, biological museums or educational laboratories. The assessment process itself is important, which is based not only on the use of questionnaires. Different types should be taken into account: work with a textbook, preparation of herbariums or other materials. The benefit of self-directed work is that it can be used in different types of training, both remote and full-time. Also, they are used at different stages of a lesson: to study a new topic, control and assessment, to consolidate a new topic (Akhmedova et al., 2022). In the process of research, an important point is the use of such types of exercises that will be a necessary element of self-assessment, for example, self-directed work. Its result is the development of the training component (comprehension of the assessment in accordance with the learned material), the improvement of the developing component (the formation of skills for self-directed study and assessment), the educational component (the development of responsibility, perseverance and diligence) and the diagnostic component (introspection of the acquired knowledge in the process of self-study).

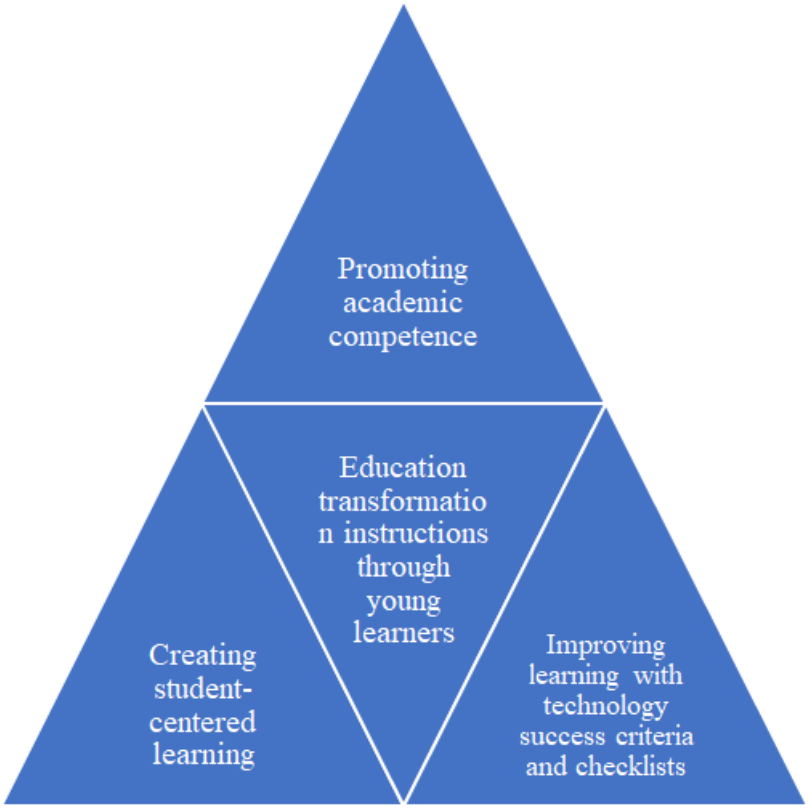


Figure 1. Developing an effective checklist model

Source: compiled by the authors.

It has been proven that when using self-directed work, information is pulled out of its processing and motivation is formed to study the subject. Each student independently tries to think through a logical chain to form the correct answer (Izbasarova and Zhylkaidarova, 2016). An important point in the process of self-assessment, as well as self-study of students, was to test their knowledge. Therefore, a rating assessment system was used, which has ample opportunities, including the age of students. Students aged 14-20 form their knowledge depending on social attitudes or attitudes towards people/themselves. In accordance with this, the teaching is supplemented by self-directed education. The use of a rating assessment system allows moving away from biased assessment, since score has a cumulative effect. This allows students to develop the ability to determine for themselves how and with what efforts to do certain tasks. The main components of the rating system are as follows:

1. Diagnostics and monitoring of the quality of education.
2. Motivating students to study the subject.
3. Creation of a single system of criteria.
4. Building relationships between teacher and students.
5. Correction of knowledge.

The use of the “Screen of Success” method (Pavlova, 2006) can improve the quality of preparation for biology with the use of ratings. Self-assessment is the

process of assessing the level of learned material by students themselves. Of greatest interest is the classification by L.V. Betsfai (1979). Accordingly, there are 3 types of self-assessment: assessment in the form of voluntary attention; proactive assessment; reflective self-assessment. Assessment in the form of voluntary attention is used if it is necessary to compare actions with a pattern, proactive assessment means comparison of actions with conditions and results, and reflective self- assessment is used when changing actions. When using the assessment method, one should pay attention to the fact that the mandatory component is the use of exercises that are classified in accordance with the proposals of L.V. Izhoykina (2013) (Table 1).

Table 1. Types of exercises for self-directed control and assessment

Stages of creating self-directed control and assessment	Object
– exercises for the formation of actions based on the results of work; – exercises for the formation of the ability to carry out planning self-directed control and assessment; – exercises for the formation of skills to compare the predicted result and the result obtained; – exercises for the formation of skills to compare the predicted result and the result obtained.	– exercises for the comparison of the work with the sample; – exercises for the performance of actions according to the model according to the detailed instructions; – exercises for self-assessment according to the algorithm; – exercises to change actions taking into account changed conditions.

Source: I.S. Sinitsyn et al. (2016).

When using the first type of assessment, one can set an example with entering the right words, or naming elements of a picture. At the same time, after this, the student should self-assess their work. Namely, in front of each of the words, marks of different colors should be put:

– red (if all the information is correct and was provided without the help of training materials);

– green (if scientific aids were used or if there are errors);

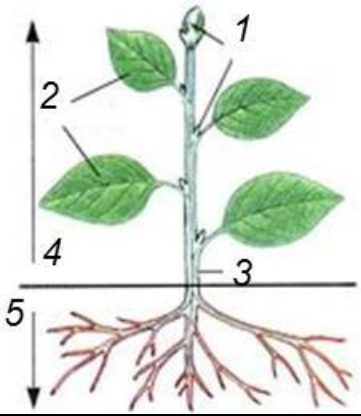
– yellow (if there were difficulties with filling) (Table 2).

Also, for self-assessment, one can use the help of their friend or desk mate, who will be able to evaluate the work and put colors in accordance with the correctness of the tasks. In addition to the coloring method, a self-assessment score is used. In other words, five points are given if the answer is correct, four points are given if one mistake is made, three points are given if two mistakes are made, two points are given if three or four mistakes are made. For the formation of operational self-assessment, it is important to use the help of a friend or a desk mate. For example, one need to describe the bird that is shown in a picture. After this task, the student should tell and show their work in order to be assessed. Also, for assessment, the student can use self-assessment questionnaires:

1. I have doubts.
2. I think there are mistakes.
3. I am sure that I completed all the tasks.

All these types allow the student to independently analyze the quality of the studied material and improve knowledge in the field of biology (Sinitsyn et al., 2016). Recently, the concept of "4K" has been reintroduced and acquired new forms, which allows students to solve tasks by developing creativity and finding a logical path based on the process of self-study, i.e., their own achievements and requirements. This also includes the concept of soft skills, which means the development of cognitive and intellectual skills, the development of the ability to manage one's own educational process and interact with other people. The use of this concept allows expanding the student's abilities at the level of self-study and develop such qualities as: ability to independently find solutions to given surveys; think critically; responsibility for the decisions made; ability to develop leadership qualities. For example, when using this method in biology classes, the student learns the ability to compare all the sciences about the Earth with each other, highlights their main tasks. Also, conceptual skills are developed as the skills of rhetoric and homiletics are involved. In this process, the student acts as a teacher and influences the knowledge of other students. To develop these skills, the teacher can ask for their own opinion on the topic, and then evaluate their performance, pointing out positive and negative characteristics. The key point when using this method is the development of thinking, for example, using the comparison of some objects with each other and the selection of similar characteristics.

Table 2. An example of a self-assessment exercise



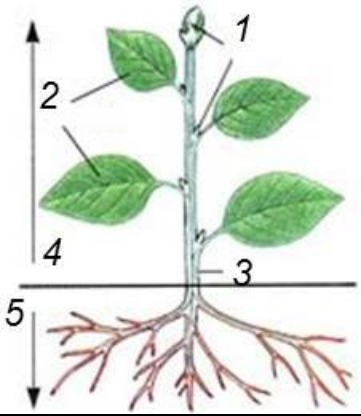


Figure 1	Figure 2

Assess yourself and color the circle that you think is right		
I completed the task correctly ◯	I completed the task with mistakes ◯	I had difficulties completing the task ◯

Source: I.S. Sinitsyn et al. (2016).

An important point in the process of studying biology is the development of the creative potential of students. To do this, in the process of self-study, it is

convenient to use interactive methods with project inclinations. Firstly, it contributes to the independent search for the necessary information, highlighting what is the most important. Second, it facilitates comparison and analysis between multiple entities. Examples of such projects are presented in Table 3. Also, in addition to the introduction of project work, it is important to use interactive technologies that will improve the motivation of students to study biology. For example, to increase interest and memorize the material, there are tasks in which students should independently create a diagram or a table, a poster, and then characterize and defend their work. This method is as positive as possible for students. This contributes to the development of responsibility in students and the search for such information that can be of interest to other students. After that, the student's attention should be paid to the creation of self-directed control and assessment of their work, to improve the quality of self-study in the next lessons. In the process of studying biology, an important point is the use of laboratory or practical work in a remote learning environment. In accordance with this, the independent performance of laboratory work contributes to the systematization and consolidation of the studied material, the use of knowledge gained during self-directed study in practice, as well as develops analytical and constructive skills (Izbasarova and Zhylkaidarova, 2016).

Table 3. Types of project lines and examples

Course name	Project lines	Examples of projects
General biology (grades 9-11)	Evolution	Hypotheses of the origin of life: myth and science
		Dinosaurs: mistake of a joke of nature
		Evolutionary origin of non-cellular life forms
	Features of the cell structure	Water is a unique liquid on Earth
		Travel of substances within the cell
		Viral disease prevention measures
	Genetics	Compiling your family tree
		Genetically modified foods: myth or reality
		Ancestors of modern animal breeds and plant varieties

Source: M.A. Magomedova et al. (2017).

In Table 4, one can see the results carried out with grade 8 students, where the experimental group used a combined type of lesson with the addition of information and communication technologies (ICT).

Table 4. Results of the knowledge control on the topic “Blood circulation”

Characteristic	Control group (%)	Experimental group (%)
Correct and complete answers	8%	10%

Errors in answers	38%	28%
Failed to complete the task	12%	6%
Knowledge quality	50%	66%
Academic performance	88%	94%

Source: K.V. Khaibulina (2012).

The result of such an experiment shows that the use of information and communication methods can improve student performance and the quality of knowledge, as the level of motivation increases. One can also see that the number of mistakes that students make has decreased. That is, as a result of the use of additional materials, both scientific and technological in nature, one can see positive feedback in the quality of knowledge, an increase in the level of motivation and student achievement.

DISCUSSION

To improve the level and quality of knowledge in the fields of many sciences, it is advisable to use the method of self-study and self-assessment in the learning process. They can be combined and used both during the lesson and when studying the material independently. In accordance with the materials of the article by G.T.L. Brown and L.R. Harris (2013), it can be seen that a high level of self-assessment in students develops the freedom of action, the desire of students to participate in the process of self-directed learning. E. Panadero et al. (2017) characterized five very different taxonomies of self-assessment and called for the development of a comprehensive typology considering, among other things, its purpose, the presence or absence of criteria, and the method. In order to improve knowledge in the field of biology, it is necessary to increase the level of motivation in students. This is exactly what is described in detail in the article by A.O. Tishchenko (2010), who considered the use of information technologies in remote learning. The research results were based on an experiment, which is highlighted in the article by K.V. Khaibulina (2012). As shown by this research, there is indeed a relationship between the use of interactive methods and increasing the level of knowledge of students. The use of electronic aids in the classroom, as well as in the process of self-study of the material, was described by N. Polyakova (2010). It should be noted that students should be involved in learning when discussing biological mechanisms, genetic problems or environmental problems according to checklists with criteria.

In learning, it is important to use different online systems, which were characterized by P. Angriani and H. Nurcahyo (2019). Moodle was characterized in the course of the research, the results of which showed that the media check score was about 3.85 points (very good), and the material check score amounted to 3.8 points. This indicates an increased level of study of the material and contributes to a better knowledge control. On the example of students from Rivers State, Nigeria, a study was conducted on the effectiveness of using the self-assessment method after conducting and studying biology. The results of the paper showed that the method of self-assessment and the complex method of peer assessment had a positive impact on students and allowed them to identify the main mistakes themselves, while the teacher assessment method worsened learning outcome (Orluwene and

Ekom Dick Ekim, 2020). The results of the study on the types of independent work and their impact on students are described in the article by S.B. Akhmedova et al. (2022). Based on this study, it can be said that independent work can be carried out in laboratories and museums, as well as with the use of different technologies. The practical significance of using the rating method was described by I.R. Pavlova (2006). This system allows students to focus on learning the material and accumulate points in accordance with the motivational component.

The development of creative abilities and approach to the study of educational material by students is helped by the soft skills method, the main task of which is the development of the right hemisphere of the brain. A creative approach to self-study contributes to the ability to create associations, logical chains that improve the memorization process. This method was characterized by V.E. Khachaturyants and A.V. Teremov (2021). Based on the creation and use of the "Scale of readiness for self-study" K. Kadriye and E.I. Sonmez (2021) came to the conclusion that the use of biology laboratory practices in the learning process allows students to maintain self-directed control and, accordingly, form students' skills for self-directed learning. A method of flipped classes has a positive impact on independent work. It is described in detail in A. Dadjari et al. (2020). Y. Choi et al. (2017) explored the impact of "active learning" on improving self-directed learning. R.Sh. Uzbasarova and K. Turgynbai (2016) studied the impact of using independent work during self-assessment. In their research, T.E.T. van Woezik et al. (2021) presented the process of using independent work while working in a team. As a consequence, teamwork increases the student's sense of purpose as well as helps to assess their knowledge and skills in relation to other students. Also, team members can help with self-assessment and increase the level of motivation.

Since the process of self-study in students should be controlled not only by the students themselves, but also by the teacher, it is advisable to have a teacher who will become a transitional link between the student and the teacher. The main tasks of teachers, as well as the process of their influence, interaction and creation of tripartite communication are described in the article by N.G. Lipkina and O.R. Pechkina (2020). But the ability to form independent research skills with the help of a tutor was studied by N.Z. Smirnova and O.V. Berezhnaya (2014). It can be seen that laboratory work and experimental study allow developing the ability to think critically, logically and creatively. In addition, the use of laboratory work in biology classes contributes to the development of skills to independently analyze and compare the objects under study. The method of their use is described in the article by R.Sh. Izbasarova and L. Zhylkaidarova (2016). To improve self-directed learning, it is important to develop logical thinking regarding many biological processes. This topic is covered in the article by M.A. Jakunchev and A.I. Kiseleva (2014).

The use of interactive methods in the process of remote learning has a positive effect on increasing interest in learning, as well as allows to detail the knowledge of students, especially if there are unknown concepts. This topic was studied by M.A. Magomedova et al. (2017). But, in addition to interactive methods, students receive a large amount of information with the help of textbooks. Therefore, it is necessary to develop the ability to use them and highlight the most necessary information. Methods for working with the textbook are described in M. Kramer et al. (2021). The research used materials from the article by I.S. Sinitsyn et al. (2016). On its basis, it

can be seen that the orientation towards the result of education has an important value in the process of forming the student's personality. In the course of this research, one can see how it is possible to use the method of self-assessment and its impact on learning outcomes. In addition, if we compare these studies with other studies conducted by other scientists, it can be seen that the complex combination of different methods, including laboratory and independent work, the correct use of electronic books and materials, the use of information and technological methods in the research process allows improving not only the level of knowledge of students in the field of biology, but also increasing the desire of students to study natural science subjects. Therefore, the purpose of this research was to analyze the methods that are used in the development of approaches. In the course of the research, it was concluded that various didactic materials, group work, and laboratory work can be used to improve the quality of self-assessment.

CONCLUSIONS

In accordance with the updated education system, self-study and self-assessment skills are important for deeper self-directed understanding of new knowledge, quick familiarization with scientific discoveries, self-development, as well as assessment of oneself and others. However, the emphasis on self-directed learning these days makes it much more difficult for students with a low level of education to form a positive social identity. During the COVID-19 pandemic, the educational process has faced many challenges, including a decrease in the level and quality of knowledge of students. Therefore, it is important to create resources that will allow students to improve their knowledge in the field of biology. The process of self-assessment and self-study can help with this. In the course of the research, it was concluded that the use of various methods of self-assessment in the learning process increases the knowledge and motivation of students to study biology, for example, to allow the students to independently check their work and analyze their mistakes after testing, or use different colors to highlight those tasks that the student wrote himself (the answer is correct), those with errors and those, with which difficulties arose. In addition, one can improve their communication skills and bonding with classmates by helping others assess their work.

In order to improve the quality of self-study in students, it is advisable to use various interactive and technological methods. For example, using information search to create a project, a film or a presentation, the student delves into the subject matter, studies the issue in detail and remembers the information better. In addition, in preparing for the lesson, they may be looking for such information to interest their friends. As for the teachers, this research paper will help them to develop learning models that enhance student self-study and self-assessment while taking responsibility for their own future. In addition, this research focuses on developing student self-directed control and assessment skills with minimal guidance from teachers. Students will receive success criteria and checklists from teachers to take care of making the most of their academic progress while at school.

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