

THE ROLE OF MICROBIOLOGICAL SITUATIONAL PROBLEMS (CASE-STUDY) IN THE DEVELOPMENT OF STUDENTS' CRITICAL THINKING

Almas A.E., 2nd year master's student of EP 7M01517 – «Biology»
aigerim.almas03@gmail.com, <https://orcid.org/0009-0002-0555-3010>

Ibadullayeva S.J., doctor of biological sciences, professor
salt_i@mail.ru, <https://orcid.org/0000-0003-3270-8364>

Korkyt Ata Kyzylorda University, Kyzylorda city, Kazakhstan

Annotation. This article examines the effectiveness of the microbiological situational task method (case study) in the development of students' critical thinking. The study involved 32 students who were offered thematic tasks on isolating microorganisms from air, soil, and water samples, analyzing colony morphology, conducting identification, and planning a research strategy. The results of the study showed that the case-study method significantly improves students' analytical thinking, logical thinking and practical laboratory skills. The data obtained indicate that the use of situational tasks in the study of microbiology increases students' interest in the subject and enhances their ability to critically evaluate complex biological phenomena.

Critical thinking in the modern higher education system is one of the main components of the formation of professional competence of future specialists. Since the science of Microbiology is based on specific situations that require practical decision-making, teaching the subject content using the case-study method effectively develops students' analytical thinking, the ability to make well-reasoned conclusions, and the skills of working with scientific information.

In conclusion, it is confirmed that situational tasks of a microbiological nature not only enhance academic motivation, but also provide a systematic understanding of complex biological processes, which is why they should be used as a permanent pedagogical tool in higher education.

Keywords: critical thinking, case-study, microbiology, laboratory experience, practical skills.

Introduction. In the modern education system, one of the main requirements, along with the assimilation of theoretical knowledge by students, is the ability to apply them in a practical situation. In this context, critical thinking is an important cognitive skill that forms the ability to analyze, evaluate, interpret information, and make informed decisions. Critical thinking is especially important in the field of microbiology, as laboratory work requires precise accuracy, logical judgment, and correct interpretation of data [1].

The effectiveness of the situational task method (case study), based on situational analysis in the educational process, has been widely proven in recent years. This method allows students to analyze specific laboratory conditions and perform tasks such as identifying microorganisms, assessing their morphological features, selecting the necessary culture media, and developing a research strategy [2]. Case-study plays an important role in developing students' skills in linking theoretical knowledge with practice, independent decision-making, and logical thinking.

In pedagogical research of the last five years, it has been proven that case-study technology is highly effective in developing students' analytical thinking, group interaction, and the ability to simulate real professional situations. Especially in the natural sciences, such as biology, microbiology, and biotechnology, the importance of situational tasks is increasing, as they are seen as universal tools for solving scientific and practical problems [4].

In the field of microbiology, factors such as changes in epidemiological conditions in recent years, the emergence of new pathogens, and the growing problem of antibiotic resistance have increased the need for students to develop research and critical thinking skills.

Teaching this discipline through the simulation of real-world laboratory and clinical situations is a modern way to enhance the professional training of future biologists and microbiologists.

In addition to increasing students' interest in the subject, the use of case studies in microbiology enhances their ability to analyze complex biological phenomena. Furthermore, recent scientific research suggests that critical thinking skills are directly linked to students' abilities to analyze data, use research methods, and draw independent conclusions [3].

In this regard, this article examines the role of microbiological case-study tasks in the development of students' critical thinking, and their effectiveness is analyzed using the example of laboratory tasks. The research is aimed at identifying effective ways to improve students' practical skills and form critical thinking in the educational process [5].

Research materials and methods. The study was conducted with the participation of 32 biology students from the Korkyt Ata Kyzylorda University. The study was aimed at determining the level of development of critical thinking skills among students using three microbiological thematic tasks (case-study).

1. Case-study method

Students were offered three laboratory assignments:

- control of microorganisms in the air by passive deposition;
- isolation of microorganisms in soil samples;
- identification of bacteria in natural water sources.

In each assignment, students described the morphology of the colony, determined possible taxonomic groups, and proposed additional research strategies. This method was aimed at developing analytical thinking, logical thinking, and decision-making skills.

2. Empirical methods (survey and self-assessment)

After the tasks, the students filled out a questionnaire of 12 questions. The survey covered four areas:

- the level of understanding of the task;
- data analysis and hypothesis building;
- decision-making and providing an alternative option;
- laboratory activity and motivation.

The students evaluated their skills on a scale from 1 to 5 and determined the dynamics of critical thinking.

3. Comparative analysis method

The indicators before and after the performance of Case-study tasks were compared. Evaluation criteria:

- the accuracy of colony classification;
- the quality of microorganisms detection;
- the correct choice of a nutrient medium;
- the logical structure in decision-making.

This method allowed to evaluate the changes in students' critical thinking skills using quantitative indicators.

4. Laboratory practice method

All laboratory work was carried out on the basis of standard microbiological technique. Samples (air, soil, water) were sown in agar MPAs, Saburo, MRS, incubated for 24-48 hours. Students recorded macro-morphological features, such as shape, color, structure, colony density, and identified microorganisms at the initial level [6]. The tools used included standard laboratory equipment (thermostat, microscope, Petri dishes, test tubes, and sterile instruments) and safe tools for collecting samples.

The collected results were systematically recorded in laboratory journals. The students described indicators such as shape, color, structure, and growth intensity of the colonies, identifying the expected taxonomic groups for each sample. At the end of each assignment,

the students were encouraged to analyze their actions, identify cause-and-effect relationships, and draw conclusions based on the data obtained. This process significantly enhanced their critical thinking skills. Table-1 shows the value of situational tasks.

Table 1 – The significance of situational tasks in developing students' critical thinking

Situational task	Significance (from the perspective of critical thinking)
1. Isolation of microorganisms in the air	<ul style="list-style-type: none"> • By assessing the microbial load in the environment, the student learns to analyze the problem. • They can compare different colony morphotypes and make informed predictions. • This helps them develop independent decision-making skills, draw specific conclusions, and organize data logically.
2. Isolation of soil microorganisms	<ul style="list-style-type: none"> • It allows you to assess the diversity of microorganisms in the natural environment. • Analytical thinking is developed by analyzing a complex system that contains several microbial groups. • It forms the ability to compare microscopic and macroscopic data.
3. Isolation of microorganisms in a water sample	<ul style="list-style-type: none"> • By analyzing microorganisms grown in various environments, logical and experimental thinking is developed. • Classification skills are formed by comparing gram-positive and gram-negative bacteria. • Based on the results obtained, the ability to draw reasonable conclusions about the sanitary quality of water is increased.

This table reflects the specific nature of each task in developing students' critical thinking skills. Each task focuses on building specific practical and analytical skills. While the air sample investigation enhances logical reasoning, the soil and water sample investigation improves data comparison and decision-making skills.

Discussion of Results. The results of the study showed that the inclusion of microbiological situational tasks (case-study) in the educational process has a significant impact on the skills of critical thinking, analysis, interpretation and laboratory decision-making by students. The results were analyzed on the basis of questionnaires, control, written responses from students, the quality of laboratory work and the dynamics of solving tasks [8].

During the study, the dynamics of students' critical thinking skills were assessed for each task. Table-2. The total number of participants is 32 students.

Table 2 – Student results by level of understanding

Task	Fully understood, %	Partially understood, %	Difficulties %
1	78	19	3
2	84	12	4
3	91	9	0

As can be seen from the table, in task 1, 78% of students fully understood the task, 19% partially understood it, and 3% faced difficulties. In task 2, the percentage of students who fully understood the task reached 84%, while those who partially understood it were 12%, and those who faced difficulties were 4%. In task 3, the level of understanding was the highest, with 91% of students fully understanding the task. This shows that students' critical thinking abilities are gradually developing through the use of laboratory tasks. Table 3 below shows the results of the students' self-assessment:

Table 3 - Results of self-assessment of critical thinking skills

Skills	Task 1	Task 2	Task 3
<i>Creating a hypothesis</i>	3.4	3.9	4.3
<i>Data analysis</i>	3.6	4.1	4.5
<i>Decision-making</i>	3.2	3.8	4.4
<i>Proposing an alternative</i>	3.1	3.6	4.2
<i>Logical reasoning</i>	3.5	4.0	4.6

This table increases students' self-esteem for each assignment. Logical thinking and decision-making skills showed the greatest growth. This proves the effectiveness of the case-study method.

Dynamics of critical thinking skills formation

1. The impact of Case-study-based tasks

The results of the study showed that microbiological situational tasks (case-study) significantly improved students' skills in analyzing information, identifying cause-effect relationships, and making decisions. (Fig. 1).

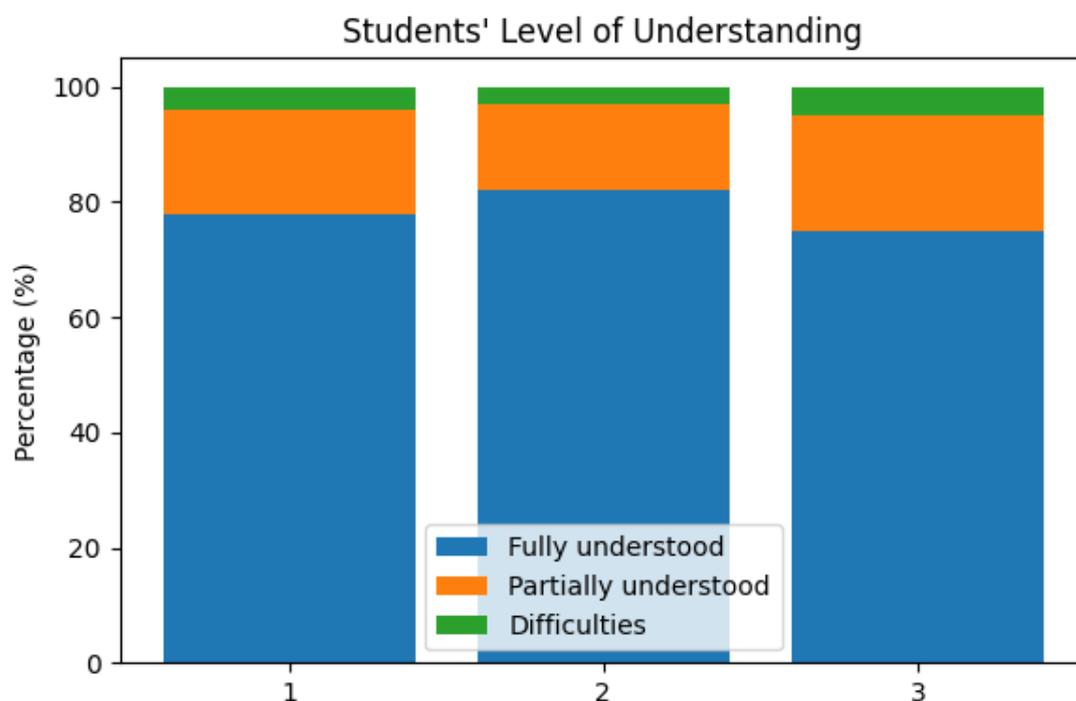


Figure 1 – Percentage of students' understanding of the task

According to the survey results, 78-91% of students stated that they were more confident than ever in such stages as describing microorganisms, comparing the morphology of colonies, analyzing pathogenicity factors, or selecting a growth medium.

During the observation of students' laboratory activities, it was noted that they had reduced the time it took them to analyze problematic situations and increased the accuracy of their decision-making [9]. For example, while 40% of students initially struggled to correctly classify colonies, this number dropped to 10% after using the case study. This proves that students have developed the ability to understand, compare, prove, and justify information, rather than simply memorizing it.

2. Improvement of microbiological practical skills

During the laboratory classes, students studied the microflora of air, water and soil, performed tasks such as the allocation of microorganisms, the creation of crops, the choice of a nutrient medium, the determination of morphological and biochemical properties [10].

Difficulties at the initial stage (when the case-study method is not used)

According to the indicators identified as a result of control and practical works:

- Mistakes in the choice of a nutrient medium-31% of students;
- Incorrect interpretation in microscopic analysis-28%;
- Inability to fully describe the morphology of the colony-35%.

These figures prove that students face some difficulties when performing laboratory assignments independently.

Changes after the implementation of Case-study

After the application of the Case-study method, the actions of students based on logical thinking improved significantly. For example, when given a specific situation (identify a potential Enterobacteriaceae species in a water sample), students correctly planned the task and significantly reduced their errors in selecting a growth medium, microscopic analysis, and describing the morphology of the colony [11]. In addition, students began to develop strategies for completing their tasks, indicating that their laboratory skills had been formed autonomously. The table-4 shows the results before and after the application of the Case-study method:

Table 4 - Changes in practical skills

Difficulty type	No Case-study, %	After using Case-study, %
Error in selecting the growth medium	31	8
Incorrect interpretation during microscopic analysis	28	6
Failure to correctly describe the morphology of the colony	35	7

In order to quantify the effectiveness of the Case-study technology, the level of errors made by students during practical microbiological tasks was analyzed. The study was conducted based on three main indicators: the correct selection and preparation of a nutrient medium, the interpretation of the results of microscopic analysis, and the morphological characteristics of bacterial colonies. Each of these indicators plays an important role in the practical content of the microbiology discipline and determines the quality of students' laboratory skills [12].

The graph below shows the relative difference between the percentage of students' errors before and after using case-study. The results of the graph clearly demonstrate the

positive impact of case studies on improving microbiological practical skills and comprehensively illustrate the effectiveness of implementing this method in the educational process. (Fig. 2).

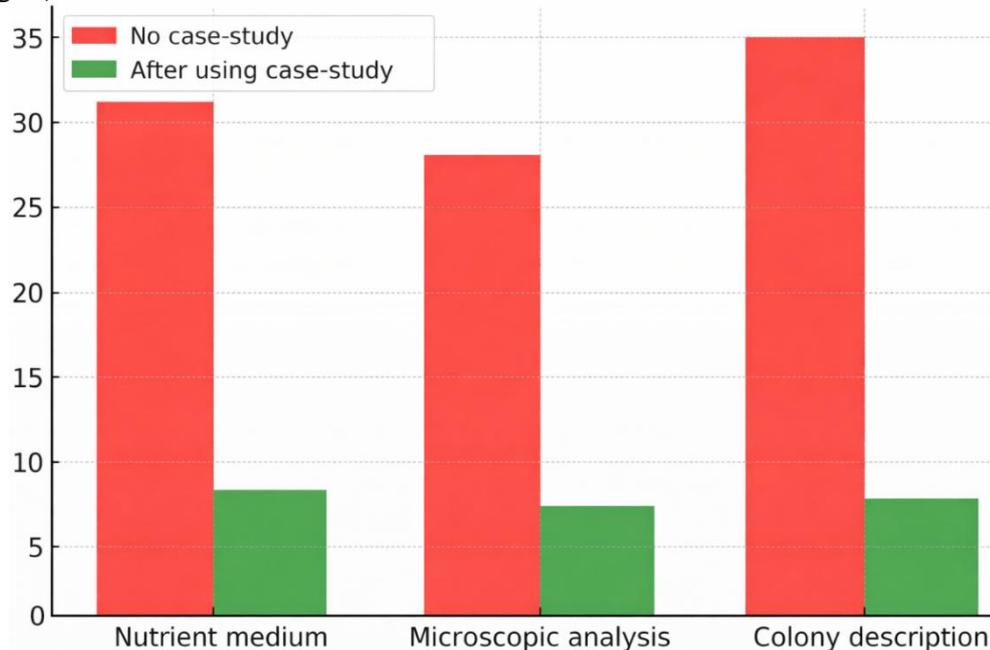


Figure 2 – Changes in practical skills errors

The figure compares the percentages of errors before and after using the case-study method. After using the method, students' practical skills improve, and the number of errors they make in class decreases. This means that the tasks were effective and yielded real results.

3. Analytical thinking and the level of argumentation

An analysis of students' written responses and case-study solutions showed that their ability to argue their points increased. During the course of their work, students:

- wrote observations based on the data;
- compared the properties of microorganisms;
- independently planned the research algorithm;
- substantiated each hypothesis.

For example, while the students initially briefly wrote only “the colony is white,” after working on the case study, they gave a detailed description: “The colony is round, with a smooth edge, with a shiny surface texture, without noticeable pigmentation, which is *Staphylococcus* spp. corresponds to the characteristic features.” This shows that a clear diagnostic mindset has been formed [13].

4. Survey results: Students' self-assessment

N = 32 students took part in the survey. According to the results:

- 87% believe that case-study helps to better understand complex microbiological information;
- 82% - said that situational tasks have increased logical thinking;
- 79% - recognized the improvement of analysis, comparison, decision-making skills;
- 91% - showed that tasks similar to a real-life practical situation increase interest in classes.

This confirms that students have accepted the case-study method as an effective tool.

5. Increased motivation to learn

The Case-study method has activated the learning process and increased students' interest in the subject. More students in the reflection at the end of the lesson:

- understanding the actual clinical and environmental significance of microbiological experiments;
- when the tasks are "close to real life", it will be more interesting to learn;
- said that he began to feel responsible for his role in the laboratory.

Practical situations allowed students to see the connection between theory and practice, which is one of the main criteria for critical thinking.

6. Discussion. The effectiveness of the Case-study method

The results obtained are consistent with current research in the field of education. In the scientific literature, it has been systematically shown that the case-study method develops in the student not only the perception of knowledge, but also the ability to analyze, synthesize and apply them [14]. During the study, students got rid of the mechanical memory of information and learned to approach the problems of research in a creative and analytical way.

Case-study is especially effective in microbiological disciplines because:

- Specific laboratory conditions are fully consistent with the learning goal;
- The processes of detecting microorganisms require logical thinking;
- Each "case" has a solution, but the task can be completed in several ways;
- The student must prove the correctness of their solution, which directly develops critical thinking.

In addition, this method has also improved students' skills in teamwork, communication, and discussion.

Conclusion. The results of the study showed the high efficiency of the method of microbiological situational tasks (case-study) in developing students' critical thinking skills. The conducted laboratory works (separation of microorganisms in air, soil and water samples, morphological description, selection of nutrient media and development of research strategy) contributed to a deeper understanding of the material by students, logical judgment and increased abilities to analyze data.

The survey results showed that students' understanding of the tasks increased with each task, with a full understanding rate ranging from 78% in task 1 to 91% in task 3. This demonstrates the maturity of students' abilities to independently analyze laboratory tasks and find effective solutions.

The results of self-assessment also show that students' critical thinking skills gradually developed and showed steady growth. In particular, the greatest growth was observed in such skills as data analysis, logical reasoning, and decision-making. This shows that the case-study method not only helps to consolidate theoretical knowledge, but also allows students to apply it in real-life laboratory settings.

In addition, the study revealed that students' errors in practical tasks also changed. The most common errors at the early stage – incorrect choice of the nutrient medium, inability to fully interpret microscopic features and inaccuracies in the description of the colony morphology-were significantly reduced after the implementation of the case-study method. This shows that students have developed not only theoretical knowledge, but also the ability to make correct decisions in specific laboratory conditions [15].

Based on the results of the study, the systematic application of the case-study method

- improves students' practical skills;
- improves the ability to make quick and accurate decisions in laboratory conditions;
- develops critical thinking, creative, and scientific research skills;
- increases interest and motivation in microbiology.

Thus, the case-study method is an effective pedagogical technology in teaching microbiology. The widespread use of this method in the educational process will help students develop a research culture, combine theoretical knowledge with practice, and enhance their professional competence as future specialists.

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СТУДЕНТТЕРДІҢ СЫНИ ОЙЛАУЫН ДАМУДА МИКРОБИОЛОГИЯЛЫҚ ЖАҒДАЙЛЫҚ ТАПСЫРМАЛАРДЫҢ (CASE-STUDY) РӨЛІ

Алмас А.Е., 7M01517 – Биология БББ-ның 2-ші курс магистранты
Ибадуллаева С.Ж., биология ғылымдарының докторы, профессор

Қорқыт Ата атындағы Қызылорда университеті, Қызылорда қ., Қазақстан

Андатпа. Бұл мақалада студенттердің сыни ойлау қабілетін дамытудағы микробиологиялық жағдайлық тапсырмалар (case-study) әдісінің тиімділігі зерттелді. Зерттеуге 32 студент қатысып, оларға ауа, топырақ және су үлгілерінен микроорганизмдерді бөліп алу, колония морфологиясын талдау, идентификация жүргізу және зерттеу стратегиясын жоспарлау бойынша жағдайлық тапсырмалар ұсынылды. Зерттеу нәтижелері case-study әдісі студенттердің аналитикалық ойлауын, логикалық пайымдауын және практикалық зертханалық дағдыларын айтарлықтай жетілдіретінін көрсетті. Алынған деректер микробиология пәнін оқытуда жағдайлық тапсырмаларды қолдану студенттердің пәнге қызығушылығын арттырып, күрделі биологиялық құбылыстарды сыни тұрғыдан бағалау қабілетін күшейтетінін дәлелдейді.

Қазіргі жоғары білім беру жүйесінде сыни ойлау – болашақ мамандардың кәсіби құзыреттілігін қалыптастырудың негізгі компоненттерінің бірі. Микробиология ғылымы практикалық шешім қабылдауды талап ететін нақты жағдайларға негізделгендіктен, пән мазмұнын case-study әдісі арқылы оқыту студенттердің аналитикалық ойлауын, дәлелді тұжырым жасауды, ғылыми ақпаратпен жұмыс істеу дағдыларын тиімді дамытады.

Қорытындылай келе, микробиологиялық бағыттағы жағдайлық тапсырмалар оқу мотивациясын күшейтіп қана қоймай, күрделі биологиялық процестерді жүйелі түсінуді қамтамасыз ететіні, сондықтан оларды жоғары білім беруде тұрақты педагогикалық құрал ретінде қолдану қажеттігі дәлелденеді.

Тірек сөздер: сыни ойлау, case-study, микробиология, зертханалық тәжірибе, практикалық дағды.

РОЛЬ МИКРОБИОЛОГИЧЕСКИХ СИТУАЦИОННЫХ ЗАДАЧ (CASE-STUDY) В РАЗВИТИИ КРИТИЧЕСКОГО МЫШЛЕНИЯ СТУДЕНТОВ

Алмас А.Е., магистрант 2-го курса ОП 7М01517 – «Биология»
Ибадуллаева С. Ж., доктор биологических наук, профессор

Кызылординский университет имени Коркыт Ата, г. Кызылорда, Казахстан

Аннотация. В данной статье рассматривается эффективность метода микробиологических ситуационных заданий (case-study) в развитии критического мышления студентов. В исследовании приняли участие 32 студента, которым были предложены тематические задания по выделению микроорганизмов из образцов воздуха, почвы и воды, анализу морфологии колонии, проведению идентификации и планированию стратегии исследования. Результаты исследования показали, что метод case-study способствует значительному развитию аналитического мышления и логического рассуждения и практические лабораторные навыки студентов. Полученные данные свидетельствуют о том, что использование ситуационных заданий при изучении предмета микробиология повышает интерес студентов к предмету и усиливает их способность критически оценивать сложные биологические явления.

Критическое мышление в современной системе высшего образования является одним из основных компонентов формирования профессиональной компетентности будущих специалистов. Поскольку наука Микробиология базируется на конкретных ситуациях, требующих принятия практических решений, обучение предметному содержанию методом case-study эффективно развивает у студентов аналитическое мышление, умение делать аргументированные выводы, навыки работы с научной информацией.

В заключение подтверждается, что ситуационные задания микробиологической направленности не только усиливают учебную мотивацию, но и обеспечивают системное понимание сложных биологических процессов, поэтому их необходимо использовать в качестве постоянного педагогического инструмента в высшем образовании.

Ключевые слова: критическое мышление, case-study, микробиология, лабораторный опыт, практические навыки.