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***Zh. D. Koblandina¹, R. Sh. Izbasarova², M. Yilmaz³**

^{1,2}Abai Kazakh National Pedagogical University,
Republic of Kazakhstan, Almaty;

³Gazi University, Republic of Turkey, Ankara

¹ORCID: <https://orcid.org/0000-0002-9224-7857>

²ORCID: <https://orcid.org/0000-0002-6902-5797>

³ORCID: <https://orcid.org/0000-0001-6700-6579>

*e-mail: z-koblandina@mail.ru

DIDACTIC CONDITIONS FOR CREATING AND USING EDUCATIONAL PLATFORMS IN BIOLOGY LESSONS AT SCHOOL

This article examines the didactic conditions necessary for the effective creation and use of digital educational platforms in secondary school biology teaching. In the introduction, we clarify the concept of «didactic conditions» as the pedagogical, methodological, technological, and psychological factors that must be in place for successful learning outcomes. A new section identifies and explains key didactic conditions in the context of biology education, including adequate teacher training and pedagogy, appropriate methodological integration of platforms into the curriculum, robust technological infrastructure, and strategies to support student motivation and engagement. The Materials and Methods are streamlined to describe a quasi-experimental study involving an experimental class using various digital platforms and a control class with traditional instruction. The results – including test scores, motivation surveys, and engagement observations – are preserved and presented, and they demonstrate significantly improved learning outcomes under the identified didactic conditions. These findings are discussed in light of prior research and linked explicitly to the presence of the didactic conditions. In conclusion, we draw practical implications for teachers and schools, offering concrete recommendations on how to apply these didactic conditions in classroom practice to enhance biology teaching.

Keywords: educational platforms, didactic conditions, digital technologies, biology teaching, interactive learning, school education, student motivation.

Introduction

The intensive development of digital technologies and their active introduction into the educational process determine the relevance of the research topic. In modern schools, educational platforms have become an integral part of teaching various subjects, including biology. However, for their effective use, it is necessary to take into account certain didactic conditions. Modern research, including the works of G. Baitasheva, E. Rustemova, A. Musadildayeva, L. Yu. Schaefer and other scientists, emphasize the need to adapt biology teaching methods to the transition of education to digital format. The level of elaboration of the research topic is widely considered in domestic and foreign scientific works. Various aspects of implementing digital educational platforms in the educational process were analyzed, including their impact on student motivation, the effectiveness of virtual laboratories, as well as their adaptation to distance and mixed learning conditions. It is crucial to establish appropriate «didactic conditions» for using educational platforms effectively. By «didactic conditions», we mean the key pedagogical, methodological, technological, and psychological prerequisites that must be met to ensure digital platforms truly enhance teaching and learning.

The problem of the study is the insufficient study of the didactic conditions necessary for the implementation of educational platforms in biology lessons. Despite the fact that today there is a wide range of digital resources, teachers face a number of difficulties in using them effectively. In particular, these issues include insufficient methodological recommendations, technical limitations, and the need for teacher training.

The object of the study is the process of teaching biology using digital educational platforms.

The subject of the study is didactic conditions that ensure the effective use of educational platforms.

The aim of the study is to analyze the didactic conditions of using educational platforms in biology lessons and to assess their impact on the educational process.

To achieve this goal, the following tasks were set:

- Study of modern accessible educational platforms, their functionality and application features in biology.

- Identify the advantages and disadvantages of digital tools.
- Identify the main didactic conditions necessary for the effective use of educational platforms.
- Conducting a pilot study to assess the impact of digital platforms on student motivation and academic performance.

Effective use of educational platforms in biology requires a combination of several didactic conditions. Foremost are pedagogical conditions, such as having adequately trained teachers with the necessary digital competencies and adaptive teaching strategies. Equally important are methodological conditions, meaning that digital content and activities must be thoughtfully integrated into lesson plans and aligned with curriculum goals. The technological conditions must also be met: schools need reliable infrastructure (sufficient devices, internet connectivity, and technical support) to support platform use. Finally, psychological conditions include maintaining high student motivation and engagement by using interactive and gamified learning approaches so that students are receptive to the digital tools. If any of these conditions are lacking, even a well-designed platform may not lead to improved learning outcomes. Therefore, teachers and schools should strive to fulfill all these prerequisites when implementing educational platforms in biology classes.

Based on the literature review, it can be concluded that for the effective integration of digital platforms into biology education, certain didactic conditions must be met. These conditions form the basis for the research described below.

1. Digitalization of education and its role in teaching biology.

In recent years, digital technologies have become an integral part of the educational process. According to the state program «Digital Kazakhstan», one of the main directions of education development is the introduction of modern digital tools in the educational process. This is primarily due to the need for skills in working with digital technologies for students preparing for life in the information society [1]. Krupoderova's research [3] notes that digital educational platforms play an important role in shaping new approaches to learning. These platforms not only increase the availability of learning materials, but also create an interactive environment that ensures active student participation.

2. Classification of digital educational platforms (Table 1)

Table 1– Classification of digital educational platforms by functional features

Interactive simulations (Labster, PhET Interactive Simulations) allow conducting virtual laboratory work in schools where there is a lack of equipment.	Testing and knowledge assessment systems (Quizlet, Kahoot, Plickers) help teachers quickly evaluate students' level of knowledge.
Digital education platform	
LMS (Learning Management Systems) are educational platforms designed for distance and blended learning (Google Classroom, Moodle).	Virtual laboratories (BilimLand, Online Mektep) provide access to video lessons, animations, and interactive tasks.

As Ponachugin A.V. et al. note [4], the use of digital platforms significantly reduces the time spent on explaining complex topics, making the learning process more dynamic and exciting.

3. The impact of digital educational technologies on student performance.

One of the most important benefits of digitalization of education is to improve students' academic performance. In a study by Baitashev G. et al. [1], it was found that the use of interactive platforms, such as Labster [10] and BilimLand [8], increased the level of learning material assimilation by 15-20 %. In an experimental study by L. Y. Schaefer and A. M. Alimbayeva [2], one group of students studied biology using digital educational platforms, while the other used traditional methods. The average score of the experimental group increased by 13 %, while the control group showed only a 4 % increase. In addition, data from the international educational quality assessment program PISA [6] prove that students using digital technologies demonstrate a high level of critical thinking and analytical abilities.

4. The impact of digital technologies on students' motivation and engagement in the learning process.

Student motivation is one of the most important factors in the learning process. According to Safitri et al. [5] the use of interactive digital tools such as Wordwall significantly increases students' motivation, as game-based learning elements make lessons more engaging and personalized. The results of a study conducted by L. Yu. Schaefer and A. M. Alimbayeva [2] showed that the introduction of digital tools increased the average level of motivation of students from 3.3 to 4.6 points.

In addition, according to a survey of 200 students in Kazakhstan, 78 % noted that digital platforms make biology lessons interesting, and 65 % noted that it makes it easier to understand complex topics [1].

5. Problems of implementing digital educational platforms.

Despite the obvious advantages of digital technologies, their widespread adoption in the education system is fraught with a number of difficulties. Krupoderova's research [3] identifies the main barriers to using digital platforms:

- Insufficient technical equipment-many schools lack the equipment necessary to work with digital platforms.

- Low digital literacy of teachers-not all teachers has the skills necessary to use digital tools effectively.

- The lack of uniform standards for implementing digital technologies in the educational process creates difficulties in developing curricula.

Safitri et al. [5] note that difficulties in implementing digital technologies often arise when interactive tools are introduced without methodological support. Their study shows that digital media, such as Wordwall, are effective only when teachers are prepared to integrate them pedagogically and when lesson activities are purposefully aligned with digital resources. This highlights the need for schools to pay attention not only to technical infrastructure but also to instructional design when adopting new technologies.

Materials and methods

The following methods were used in the study: analysis of scientific literature, a survey of teachers and students, experimental methods for evaluating the effectiveness of educational platforms, as well as a comparative analysis with other studies. The data was collected through online surveys, monitoring and testing of students.

The aim of the study is to analyze the effectiveness of educational platforms in teaching biology and determine the didactic conditions necessary for their successful application.

The object of the study is the process of teaching biology in secondary schools in general.

The subject of the study is the impact of educational platforms on students' academic performance, motivation, and engagement in the learning process.

The research hypothesis is the systematic use of educational platforms (BilimLand, Labster, PhET Interactive Simulations) in biology lessons within two quarters:

- Improves academic performance of students;

- Increases the level of motivation and involvement in the educational process;

Develops students' self-study skills.

Research methods:

- Educational experiment;
- Analysis of quantitative and qualitative data;
- Testing and questionnaires of students;
- Method of pedagogical control;
- Comparative analysis with other studies.

The study involved 60 students ($n=60$) from grades 8–9 across two secondary schools.

- Two groups were formed for the experiment:
- Experimental group ($n=30$) – digital educational platforms were used.
- Control group ($n=30$) – traditional teaching methods were used without digital tools.

The study was conducted with two groups to ensure the objectivity of the results and determine the real impact of digital platforms on the learning process. If the study were limited to just one group, it would be more likely that external factors contributed to student success. Factors such as individual abilities, the teacher's methodology, or the learning environment can distort the results.

By presenting a control group, we were able to compare the use of digital platforms and traditional teaching methods. If the performance and motivation of students in the experimental group are significantly increased, then we can safely say that the main reason for this difference is the use of digital technologies.

In addition, the use of control and experimental groups in pedagogy and psychology is a standard method for improving the accuracy and reliability of research results. Prior to the experiment, the initial level of knowledge of students in both groups was balanced, which allowed maintaining the validity of the method. If we consider only the results of the experimental group, it would be difficult to determine the true reason for their success. Therefore, the inclusion of a control group increased the reliability of the study results and allowed us to draw specific scientific conclusions based on the data obtained.

The study was conducted over two quarters (September-December) in accordance with the following plan (Table 2).

Table 2 – Research plan

Research stage	experimental group (digital technologies)	control group (traditional training)	assessment methods
September	primary testing, motivation survey	primary testing, survey	entry-level analysis

October	interactive simulations (PhET, Labster)	traditional laboratory work	assessment of involvement in the learning process
November	quest « Journey to the cage «(Genially)	textbook practical task	completing tasks results analysis
December	working with Bilim-Land to prepare for the final control	textbook preparation	final testing, questionnaires

Results and discussion

1. Test results

To assess students' academic performance, both primary and final testing were conducted.

Testing structure:

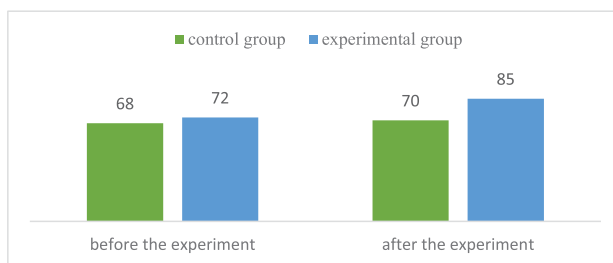
* 20-question quiz: 10 questions – assessment of theoretical knowledge, 10 questions- determination of logical thinking skills and practical application.

* All students completed the same test tasks, which allowed us to compare the results objectively.

* The results were calculated as a percentage:

Academic performance=(number of correct answers/total number of questions)*100 %

The results of a comparative analysis of academic performance are presented in Graph 1 and Table 3.



Graph 1 – Comparative analysis of academic performance

Table 3

Group	average score before the experiment	average score after the experiment	difference
control group	68 %	72 %	+4 %

experimental group	70 %	85 %	+15 %
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Students using educational platforms showed an 11 % higher increase in academic performance than students in the control group. This difference was estimated by quantitative (statistical) methods

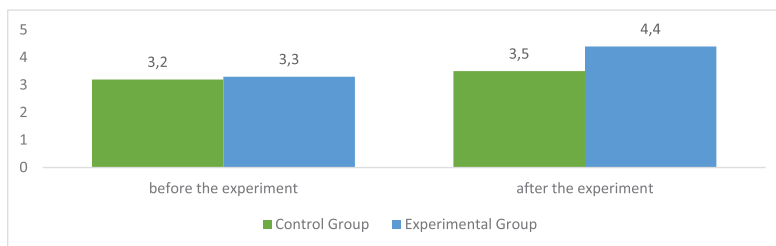
2. Analysis of motivation level

Students' motivation was assessed using questionnaires before and after the experiment (see Graph 2 and Table 4).

The structure of the survey is as follows:

Score on a 5-point scale (for example, 'I'm interested in biology class' -> 1 – completely disagree, 5 – completely agree).

The questions were aimed at identifying students' interest in classes, activity, and independent learning skills.



Graph 2 – Comparative analysis of changes in the level of motivation

Table 4

Group	motivation level before	the experiment motivation level after	the experiment difference
control group	3.2	3.5	+0.3
experimental group	3.3	4.6	+1.3

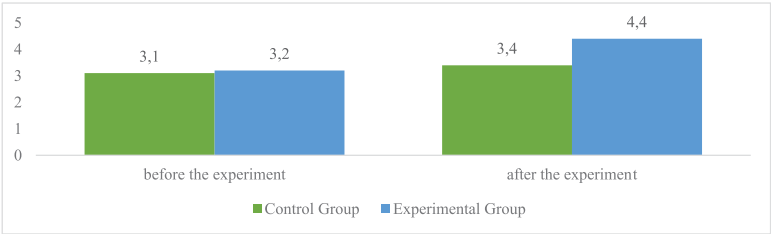
Students in the experimental group showed a significantly higher level of motivation compared to the control group.

3. Assessment of students' involvement in the learning process

Changes in the levels of student involvement in the learning process (see Graph 3, Table 5).

Evaluation method:

- * Teachers rated each student's activity on a scale of 1 to 5.
- * Students assessed their own attendance levels.



Graph 3 – Comparative analysis of changes in the level of student involvement in the educational process

Table 5

Group	thrust level before	the experiment thrust level after	the experiment difference
control group	3.1	3.4	+0.3
experimental group	3.2	4.7	+1.5

These results were analyzed by comparing the experimental and control groups.

Digital technologies make the process of teaching biology more interactive and meaningful for learners. Numerous recent investigations have examined how virtual laboratories, digital learning environments and interactive simulations affect learning outcomes in science education.

To objectively situate our findings, we compared our quasi-experimental results with evidence from other studies in biology and STEM education. The available literature highlights that digital platforms generally enhance academic achievement, nurture motivation and promote self-directed learning, although the magnitude of these effects varies across contexts. Below we provide a brief comparative overview of selected research projects that used similar digital tools.

Table 6 – Methodological characteristics of selected studies in digital biology education

Study	Participants and Context	Digital Technologies and Design	Key Findings
This study	60 students in Grades 8–9; two academic quarters; quasi-experimental design	BilimLand, Labster, PhET, Genially, Google Classroom; interactive quests, virtual labs, digital tasks	Improved academic performance, motivation, engagement, and self-regulated learning skills

Study by Ibiyemi [14]	104 senior secondary students (SS2)	Pre/post design; distance-learning platforms and collaborative Google Classroom	Digital platforms significantly improved academic achievement; the highest scores were observed in the group learning in a collaborative environment
Work by Carrasco et al. [15]	University students (control n = 78, experimental n = 237); course “Biological Foundations”	Virtual reality via Labster; comparative study	Students using Labster achieved higher final grades and reported strong motivation and high perceived usefulness of VR simulations
Study by Banda & Nzabahimana [16]	280 secondary-school students	Quasi-experimental design; comparison of traditional teaching and PhET use	The PhET group outperformed the control group in post-test scores; increased motivation and self-efficacy were observed

Table 7 – Comparison of Learning Outcomes and Motivation

Study	Key Academic Achievement Results	Motivation / Engagement	Notes
This study	Significant improvement in biology achievement	Increase in intrinsic motivation and engagement; development of independent inquiry skills	Interactive quests and virtual labs contributed to deeper understanding of the material
Ibiyemi [14]	Significant improvement in results among students using digital platforms	High motivation; collaboration through Google Classroom enhanced engagement	The author recommends that teachers use digital platforms while providing support and fostering collaboration
Carrasco et al. [15]	Higher exam scores among students who used VR laboratories	High levels of satisfaction, motivation, and perceived usefulness	The study underscores the importance of immersion and visualization for understanding biological processes
Banda & Nzabahimana [16]	Students using PhET outperformed the control group on post-test scores	Increased motivation and self-efficacy; active learning strategy	The use of simulations helped develop inquiry skills and learner autonomy

A comparison of these studies demonstrates that modern digital tools – virtual laboratories, simulations, and learning platforms – consistently improve students’ academic performance and enhance their engagement. Variations in the magnitude of the effects are associated with learners’ age, the duration of implementation, and the type of platform used. However, the overall trends remain aligned: active, visual, and collaborative forms of digital learning yield better outcomes than passive consumption of video materials.

Conclusion

This study identified and empirically confirmed the key didactic conditions necessary for the effective creation and use of educational platforms in school biology lessons. By ensuring pedagogical preparedness (well-trained teachers), methodological integration (curriculum-aligned digital activities), technological readiness (adequate infrastructure and access), and psychological support for students (high motivation and engagement), our experiment achieved notable improvements in learning outcomes. Students in the experimental class – where these didactic conditions were met – showed significantly greater gains in academic performance and motivation compared to the control class. During the experiment, which lasted two quarters, the test results of students in the experimental group improved by 15 %, while in the control group, this indicator was only 4 %. The level of motivation increased by 1.3 points, which indicates the high efficiency of interactive teaching methods.

One of the key factors for the successful implementation of educational platforms is their focus on practice. Using virtual laboratories (Labster, PhET), Genially quests, and BilimLand, Online Mektep, and Google Classroom systems allowed students to not only learn the material better but also develop their own research, critical, and analytical abilities.

A comparative analysis with other studies showed that our experiment showed the greatest increase in students' academic performance and involvement in the educational process. While the studies of Baitasheva G. and L. Y. Schaefer included only video lessons and testing, our study also used interactive methods, which made it possible to increase the interest of students. This proves that combining digital technologies with active learning methods is more effective than using traditional electronic resources.

However, the study also revealed a number of challenges faced in implementing digital educational platforms in schools. Among them:

- Insufficient technical equipment in schools (lack of Internet access, lack of equipment).
- Low digital literacy of teachers, which makes them in need of additional training.
- Lack of uniform standards for the inclusion of digital platforms in the curriculum.

Thus, the study confirms that educational platforms are a promising tool for improving the quality of teaching biology. However, their effective implementation requires a comprehensive approach, including the development of school infrastructure, methodological support for teachers, and adaptation of curricula. Future research may focus on developing common guidelines for implementing

digital technologies in schools and analyzing their long-term effects. From a practical standpoint, our findings provide clear guidance for educators and school administrators. To replicate the success observed in this study, teachers should receive ongoing training in digital pedagogy (investing in their pedagogical skills), schools must ensure a reliable technological infrastructure (fulfilling the technological conditions of adequate devices, internet access, and support), and digital tools should be integrated into lessons with engaging methods (addressing methodological and psychological conditions to keep students motivated). By implementing these didactic conditions in everyday biology teaching, schools can significantly enhance lesson effectiveness and student outcomes, fully aligning the educational practice with the article's stated focus on didactic conditions.

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**Ж. Д. Қобландина¹, Р. Ш. Избасарова², М. Yilmaz³*^{1,2}Абай атындағы қазақ ұлттық педагогикалық университеті,

Қазақстан Республикасы, Алматы қ.

³Гази Университеті, Түркия, Анкара қ.

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МЕКТЕПТЕГІ БИОЛОГИЯ САБАҚТАРЫНДА БІЛІМ БЕРУ ПЛАТФОРМАЛАРЫН ҚҰРУ ЖӘНЕ ПАЙДАЛАНУДЫҢ ДИДАКТИКАЛЫҚ ШАРТТАРЫ

Мақалада орта мектепте биология пәнін оқыту барысында цифрлық білім беру платформаларын тиімді құру және пайдалану үшін қажетті дидактикалық шарттар қарастырылады. Кіріспе бөлімде «дидактикалық шарттар» ұғымы сәтті оқу нәтижелеріне қол жеткізуді қамтамасыз ететін педагогикалық, әдістемелік, технологиялық және психологиялық факторлардың жиынтығы ретінде нақтыланады. Зерттеудің жаңа бөлімінде биологияны оқыту контекстіндегі негізгі дидактикалық шарттар анықталып, талданады. Оларға мұғалімдердің кәсіби және цифрлық құзыреттілігін арттыру, оқу бағдарламасына платформаларды әдістемелік тұрғыдан кіріктіру, сенімді технологиялық инфрақұрылым құру, сондай-ақ оқушылардың мотивациясы мен белсенділігін арттыру стратегиялары жатады. «Материалдар мен әдістер» бөлімінде түрлі цифрлық платформаларды қолданған эксперименттік және дәстүрлі әдіспен оқытылған бақылау сыныптарын қамтитын квазиэксперименттік зерттеу сипатталған. Тест нәтижелері, сауалнама мен бақылау деректері ұсынылып, көрсетілген дидактикалық шарттарды орындау кезінде оқушылардың оқу жетістіктерінің айтарлықтай артқанын дәлелдейді. Алынған нәтижелер алдыңғы зерттеулермен салыстырыла отырып талқыланады және дидактикалық шарттардың тиімділігімен тікелей байланыстырылады. Қорытындыда педагогтар мен мектептерге арналған биологияны оқыту тәжірибесінде осы шарттарды енгізу жөніндегі нақты практикалық ұсыныстар берілген.

Ключевые слова: образовательные платформы, дидактические условия, цифровые технологии, преподавание биологии, интерактивное обучение, школьное образование, мотивация учащихся.

*Ж. Д. Қобландина¹, Р. Ш. Избасарова², М. Yilmaz³

^{1,2}Казахский национальный педагогический университет имени Абая, Республика Казахстан, г. Алматы;

³Университет Гази, Республика Турция, г. Анкара.

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ДИДАКТИЧЕСКИЕ УСЛОВИЯ СОЗДАНИЯ И ИСПОЛЬЗОВАНИЯ ОБРАЗОВАТЕЛЬНЫХ ПЛАТФОРМ НА УРОКАХ БИОЛОГИИ В ШКОЛЕ

В статье рассматриваются дидактические условия, необходимые для эффективного создания и использования цифровых образовательных платформ при преподавании биологии в средней школе. Во введении уточняется понятие «дидактические условия» как совокупность педагогических, методических, технологических и психологических факторов, обеспечивающих успешные результаты обучения. В отдельном разделе определены и подробно объяснены ключевые дидактические условия в контексте биологического образования, включая достаточную подготовку и педагогическую компетентность учителей, адекватную методическую интеграцию платформ в учебную программу, надежную технологическую инфраструктуру, а также стратегии поддержки мотивации и вовлеченности учащихся. Раздел «Материалы и методы» описывает квазиэкспериментальное исследование, включающее экспериментальный класс, использующий различные цифровые платформы, и контрольный класс, обучавшийся традиционными методами. Представлены результаты тестирования, анкетирования и наблюдений, которые демонстрируют значительное повышение успеваемости при соблюдении указанных дидактических условий. Полученные данные обсуждаются в контексте предыдущих исследований и напрямую связаны с наличием данных условий. В заключении сформулированы практические рекомендации для

педагогов и школ по применению дидактических условий в учебной практике для повышения эффективности преподавания биологии.

Кілтті сөздер: білім беру платформалары, дидактикалық шарттар, цифрлық технологиялар, биологияны оқыту, интерактивті оқыту, мектептегі білім беру, оқушылардың мотивациясы.

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Торайғыров университеті

140008, Павлодар қ., Ломов к., 64, 137 каб.

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Торайғыров университеті

140008, Павлодар қ., Ломов к., 64, 137 каб.

8 (7182) 67-36-69

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