JOURNAL OF CULTURAL ANALYSIS AND SOCIAL CHANGE

Journal of Cultural Analysis and Social Change,
2025, 10(3), 2147-2152
ISSN: 2589-1316

Application Exploration of Modern Educational Technology in Biology Teaching at Vocational Colleges

Huinan Xu[1], Chaldanbaeva A.K[1], Xianzhou Geng[1], Guangyan Zhang[2]*, Marina Dzhumabaeva[2], Aysulu Bayalieva[1]

[1]*School of Education, Kyrgyz State University named after I Arabaev, Bishkek720026, Kyrgyzstan*
[2]*School of Economics and Management, Kyrgyz State University named after I Arabaev, Bishkek720026, Kyrgyzstan; Email: 1833750367@qq.com*

*__Corresponding Author:__ 1833750367@qq.com

Citation: Xu, H., K, C. A., Geng, X., Zhang, G., Dzhumabaeva, M., & Bayalieva, A. (2025). Application Exploration of Modern Educational Technology in Biology Teaching at Vocational Colleges. *Journal of Cultural Analysis and Social Change*, *10*(3), 2147–2152. https://doi.org/10.64753/jcasc.v10i3.2721

Published: December 03, 2025

ABSTRACT

This paper focuses on the traditional teaching model in biology education at vocational colleges and explores the application of modern educational technology in teaching. Traditional teaching is teacher-centered, with students lacking opportunities for active participation. The content updates slowly, and experimental designs are monotonous, failing to meet the needs of cultivating high-quality, skilled talents. To address these issues, this study proposes teaching reforms using modern educational technology, including integrating digital resources, constructing hybrid online-offline teaching models, and leveraging big data and artificial intelligence for personalized teaching. These measures enrich teaching methods, enhance teaching effectiveness, and improve student experiences. The study also emphasizes the shift from a "teacher-centered" to a "student-centered" approach, combining theory with practice through virtual laboratories and online experimental platforms to create a more interactive learning environment. The introduction of interdisciplinary integration broadens students' horizons and cultivates their comprehensive quality and innovative thinking. Additionally, support measures for teacher professional development, such as technical training, team collaboration, and optimized evaluation mechanisms, provide a guarantee for improving teaching quality. Overall, modern educational technology offers new ideas for biology teaching reforms, promotes educational modernization, and provides references for cultivating high-quality talents that meet market demands.

Keywords: Vocational colleges, Biology teaching, Modern educational technology, Teaching reform.

PROBLEMS IN BIOLOGY TEACHING AT VOCATIONAL COLLEGES

Traditional teaching models in biology education at vocational colleges face several challenges. First, teaching is primarily based on theoretical instruction, with students passively receiving knowledge and lacking opportunities for active participation and critical thinking. This approach not only dampens students' enthusiasm for learning but also hinders their ability to truly grasp theoretical concepts. Second, experimental sections are rigidly designed and monotonous, lacking innovation and appeal. Limited by space and equipment, students have few opportunities for hands-on practice, restricting the development of practical skills. Additionally, the slow update of teaching content disconnects it from real-world applications, making it difficult to engage students' interest. This model neglects the development of comprehensive abilities such as critical thinking, innovation, problem-solving, and teamwork, which are essential for meeting the demands of modern enterprises (Meghan, Rivka, & Christne, 2021). In the context of rapid social and economic development, enterprises increasingly value practical skills and innovative thinking in their workforce (Stern et al., 2017). Therefore, vocational colleges urgently need to break

away from traditional models and explore more innovative and practical teaching methods to enhance teaching effectiveness and cultivate high-quality, skilled talents that meet market demands (Dufour, 2004).

APPLICATION EXPLORATION OF MODERN EDUCATIONAL TECHNOLOGY IN BIOLOGY TEACHING

With the rapid development of modern educational technology, the teaching process model in biology education at vocational colleges needs continuous innovation and optimization to meet the diversified needs of modern education. Exploring how to integrate modern educational technology into biology teaching to create more interactive, practical, and personalized teaching models has become an important direction for educational reforms in vocational colleges (Brookhart, 2011).

Empowerment of Biology Teaching by Modern Educational Technology

Modern educational technology has brought profound changes to biology teaching in vocational colleges. On one hand, by integrating digital teaching resources such as online course platforms, virtual laboratories, multimedia courseware, and teaching videos, teachers can present complex biological knowledge in a more vivid and intuitive manner. This helps students overcome learning barriers while reducing experimental costs and safety risks. On the other hand, the construction of hybrid online-offline teaching models combines the flexibility of online teaching with the interactivity of offline teaching, meeting the diverse learning needs of students and stimulating their interest and initiative (Qiu, 2024). Additionally, the application of big data and artificial intelligence technologies enables more precise analysis of students' learning behaviors and outcomes, providing feedback to teachers for personalized teaching path design and tutoring, thereby further improving teaching quality and student learning experiences (Xu, 2018). The integration of these technologies not only enriches teaching methods but also injects new vitality into biology teaching, making it more adaptable to modern educational needs.

Integration and Application of Digital Teaching Resources.

Using modern educational technology, teachers can integrate a wealth of digital teaching resources, such as online course platforms, virtual laboratories, multimedia courseware, and teaching videos. These resources not only enrich teaching content but also help students better understand and master biological knowledge through interactive and visual means. For example, virtual laboratories allow students to conduct biological experiments in a virtual environment, breaking through the limitations of traditional laboratory time and space while reducing experimental costs and safety risks (Jiang and Feng, 2007).

In the context of integrating digital teaching resources into biology experimental teaching, multimedia courseware demonstrates significantly superior effectiveness in explaining content such as experimental operations and instrument assembly—an advantage that traditional teaching models struggle to match. Conventional biology experimental classes rely heavily on students' pre-class preparation and teachers' pre-experiment explanations. However, due to time constraints, teachers often find it challenging to demonstrate all standardized operations thoroughly within a limited period; prolonged explanations tend to cause student restlessness, ultimately reducing the experimental class to a mere formality rather than a hands-on learning experience. By contrast, video-based teaching resources, with their vivid audio-visual effects and rich embedded teaching information, leverage dual stimulation of students' visual and auditory senses. This not only enhances students' attention retention but also enables them to grasp key operational points and instrument assembly procedures more quickly. This advantage is particularly pronounced in large experimental classes with more than 20 students, where traditional one-to-one guidance is impractical. Videos allow students to review complex operational steps repeatedly at their own pace, effectively addressing the issue of uneven learning outcomes caused by large class sizes and further complementing the practical teaching support provided by virtual laboratories.

For example, in the first session of the biochemistry experiment course (titled "Practice of Basic Biochemistry Operations"), three cohorts of students from the 2022, 2023, and 2025 intakes, majoring in Biochemistry, Food Biology, and Zoology, were divided into separate experimental groups. For each major, one class (Class 1) out of two was taught using a combined teaching model of video instruction and teacher explanation, while the other class (Class 2) received only in-class teacher lectures. The same teachers were assigned to teach the same major across both groups to ensure consistency. A satisfaction survey and sample assessment were conducted, and the results are presented in Table 2.1.1. The results show that for the combined teaching model of video and teacher instruction, the proportion of students who reported "very satisfied" was over 68%, and the total proportion of students who reported "satisfied" or "very satisfied" reached more than 90%. In contrast, for the traditional teaching model with only teacher lectures, the proportion of students who reported "very satisfied" was below 50%. Regarding the evaluation of video teaching effectiveness, student satisfaction with video-based teaching was significantly higher than that with the traditional method.

Table 1. Evaluation of teaching methods for basic operation experiments in analytical chemistry by three cohorts of students

Survey Items	Options	Student Satisfaction Percentage (3 Cohorts)					
		Biochemistry		Food Biology		Zoology	
		Class 1 （	Class 2 （	Class 1 （	Class 2 （	Class 1 （	Class 2 （175
Satisfaction Level with Video Teaching	Very	91(68.9%)	—	102	—	126	—
	Satisfied	33	—	31	—	40	—
	Neutral	8 (6.1%)	—	10 (7.0%)	—	12 (6.7%)	—
	Dissatisfi	0 (0.0%)	—	0 (0.0%)	—	0 (0.0%)	—
Satisfaction Level with the Teacher-Led Lecture Teaching Model	Very	—	50	—	61	—	70 (40%)
	Satisfied	—	58	—	66	—	72 (41.1%)
	Neutral	—	21	—	15	—	28 (16.0%)
	Dissatisfi	—	2 (1 .5%)	—	0 (0.0%)	—	5(2 .9%)
Evaluation of Video Teaching Effectiveness	Facilitates	120	—	133	—	171	—
	Contribut	127	—	140	—	173	—
	Stimulate	128	—	139	—	169	—
Evaluation of Teacher Lecture Effectiveness	Facilitates	—	78	—	82	—	96 (84.9%)
	Contribut	—	90	—	86	—	95 (54.3%)
	Stimulate	—	65	—	73	—	87 (49.7%)
Suggestions and Desired Teaching Models to Be	Video	125	117	130	121	158	153 (87.4%)
	Teacher	7 (53%)	14 (0.7%)	13 (9.1%)	21	20	22 (12.6%)

Construction of Hybrid Online-Offline Teaching Models.

Hybrid teaching models combine the flexibility of online teaching with the interactivity of offline teaching, better meeting the diverse learning needs of students (Ma, Zeng and Wang, 2019). Teachers can use online platforms to release preview materials, assign homework, and conduct online discussions, while using offline classrooms for key explanations and practical operations. This model not only improves teaching efficiency but also stimulates students' interest and initiative through diversified teaching methods.

Big Data and Artificial Intelligence for Personalized Teaching.

Modern educational technology can analyze students' learning behaviors and outcomes through big data, providing precise feedback to teachers. Teachers can adjust their teaching strategies based on this data to achieve personalized teaching (Dai, Xu and Chen, 2018). For example, using artificial intelligence-assisted teaching systems, students can be provided with personalized learning paths and tutoring to better grasp biological knowledge.

Innovative Applications of Teaching Process Models

With the support of modern educational technology, the teaching model of biology in vocational colleges has shifted from a "teacher-centered" to a "student-centered" approach, focusing more on students' active participation and the development of practical skills (Barr & Tagg, 1995). By integrating resources such as virtual laboratories and online experimental platforms, teachers closely combine theoretical knowledge with practical operations, creating a more interactive and application-oriented learning environment for students. At the same time, the concept of interdisciplinary integration has been widely introduced, breaking down disciplinary boundaries and combining biology with chemistry, physics, information technology, and other disciplines (Morrison and Raymond, 2009). This broadens students' knowledge base and cultivates their comprehensive quality and innovative thinking. These innovations not only improve teaching effectiveness but also lay a solid foundation for students' future career development.

Student-Centered Teaching Design.

With the support of modern educational technology, teachers should shift from a "teacher-centered" to a "student-centered" teaching model. By using group discussions, project-based learning, case analysis, and other methods, teachers can guide students to actively participate in the learning process. For example, in physiology teaching, teachers can design real-life cases for students to discuss in groups and propose solutions, thereby cultivating their ability to analyze and solve problems.

Integrated Theoretical and Practical Teaching Model.

Biology, being a highly practical subject, benefits greatly from modern educational technology in practical teaching. Teachers can design diversified practical projects using tools such as virtual laboratories and online experimental platforms, helping students apply theoretical knowledge to practical operations. At the same time, modern educational technology can be used to record students' experimental processes and results, facilitating real-time guidance and evaluation by teachers.

Interdisciplinary Integrated Teaching Model.

Modern educational technology supports teachers in breaking down disciplinary boundaries and integrating biology with other disciplines such as chemistry, physics, and information technology (Herschbach, 2011). For example, in molecular biology teaching, combining chemical knowledge to explain the structure and function of biomolecules and using information technology to display molecular models can help students better understand complex concepts. This interdisciplinary integrated teaching model helps cultivate students' comprehensive quality and innovative thinking.

Support and Guarantee for Teacher Professional Development

The professional development of biology teachers in vocational colleges requires systematic support and guarantees. By strengthening training in modern educational technology, teachers can master new teaching tools and methods, enhance their information-based teaching capabilities, and keep up with the latest disciplinary trends. At the same time, online collaboration platforms can facilitate team collaboration among teachers, who can share teaching resources, exchange experiences, and jointly design courses and teaching activities, thereby enhancing their teamwork and innovation capabilities and improving overall teaching quality. Additionally, optimizing teaching evaluation and feedback mechanisms through big data and online platforms can precisely analyze students' learning outcomes and teachers' teaching quality, providing a basis for teachers to improve their teaching methods (Liu and Yin, 2024). These measures collectively provide strong support for teacher growth and the improvement of teaching quality.

Teacher Training and Capacity Building

Vocational colleges should strengthen training in modern educational technology for biology teachers to help them master new teaching tools and methods. For example, through the "National Vocational Education Training" program, teachers can participate in training courses combining online and offline elements to enhance their information-based teaching capabilities. At the same time, teachers are encouraged to attend academic exchanges and teaching seminars to stay updated with the latest disciplinary trends and applications of modern educational technology.

Team Building and Collaboration

Modern educational technology facilitates collaboration among teaching teams. Teachers can share teaching resources and exchange experiences through online collaborative platforms, jointly designing courses and teaching activities. For example, establishing a "Teacher Professional Development Studio" (Mi, 2013) can promote cooperation and innovation among teachers, enhancing the overall teaching quality of the team.

Optimization of Evaluation and Feedback Mechanisms.

Utilizing modern educational technology, a scientific and rational teaching evaluation mechanism can be established. Big data analysis can be employed to assess students' learning outcomes and teachers' instructional quality (Pistilli & Arnold, 2010). For instance, the feedback function of online teaching platforms can be used to promptly collect students' opinions and suggestions on teaching, aiding teachers in refining their instructional methods.

CONCLUSION

This study examines the current state of biology teaching in vocational colleges and explores the application and innovation of modern educational technology in teaching. Traditional teaching models are teacher-centered, with students passively receiving knowledge and lacking opportunities for active exploration. Additionally, the slow update of teaching content and monotonous experimental designs fail to meet the needs of cultivating high-quality, skilled talents. To address these issues, this paper proposes reform strategies based on modern educational technology, including integrating digital teaching resources, constructing hybrid online-offline teaching models, and leveraging big data and artificial intelligence for personalized instruction (Zhang and Mou, 2014). These measures effectively enrich teaching methods, enhance teaching effectiveness, and improve student learning experiences.

In terms of teaching model innovation, the shift from a "teacher-centered" to a "student-centered" approach is emphasized. By integrating resources such as virtual laboratories and online experimental platforms (Chen and Yang, 2014), theory and practice are closely combined to create a more interactive learning environment for students. The introduction of interdisciplinary integration further broadens students' knowledge base and fosters their comprehensive quality and innovative thinking (Herschbach, 2011). Meanwhile, support measures for teacher professional development, such as training in modern educational technology, collaborative teaching teams, and optimized evaluation mechanisms, provide a strong guarantee for teacher growth and the improvement of teaching quality.

In summary, modern educational technology offers new ideas for the reform of biology teaching in vocational colleges. By optimizing teaching models and strengthening teacher training, the shortcomings of traditional teaching are effectively addressed, and the modernization of biology education is promoted. This provides important references for cultivating high-quality, skilled talents that meet market demands.

Funding: Project Funding and Research Fund: Chongqing Municipal Social Science Planning Project "Xi Jinping's Key Insights on Strengthening the Awareness of the Chinese Nation as a Community" (No. 2024NDYB015). Chongqing Municipal Education Science "14th Five-Year Plan" 2024 Teaching Reform Research Specialized Key Issues "Research on the Integration of Excellent Traditional Culture and Ideological and Political Education in Colleges and Universities in the New Era" (No. K24ZG3090029).
Data Availability Statement: The data that support the findings of this study are available from the corresponding author (G.Z.) upon reasonable request.
Conflicts of Interest: The authors declare no conflicts of interest.

REFERENCES

Barr, R. B., Tagg, J. (1995). *From teaching to learning: A new paradigm for undergraduate education*. Change, 27(6), 12–25.
Boyle, R. A., Moody, E. R., Babcock, G., McShea, D. W., Carretero, S. Á., Lenton, T. M., & Donoghue, P. C. J. (2025). *Persistence selection between simulated biogeochemical cycle variants for their distinct effects on the Earth system.* Proceedings of the National Academy of Sciences of the United States of America, 122(7).
Brookhart, S. M. (2011). *Educational assessment knowledge and skills for teachers.* Educational Measurement: Issues and Practice, 30(1).
Chen, R., Yang, C. (2014). *Quantified self: New opportunities in educational research in the era of big data.* Modern Educational Technology, 24(11), 5–11.
Dai, Y. H., Xu, B., Chen, H. J. (2018). *The promotion of artificial intelligence in blended learning and the construction of an ecological chain.* Modern Distance Education Research, 152(2), 24–31.
Dufour, R. (2004). *Schools as learning communities.* Educational Leadership, 61(8), 6–11.
Herschbach, D. R. (2011). The STEM initiative: *Constraints and challenges.* Journal of STEM Teacher Education, 48(1), 96–122.
Jiang, H.-P., Feng, H. (2007). *The influence of virtual reality both on biology experiment and teaching.* HEREDITAS, 29(12), 1529–1532.
Liu, B. Q., Yin, H. H. (2024). *Empowering teachers' digital literacy through artificial intelligence: Strategies, scenarios, and evaluation feedback mechanisms.* Modern Educational Technology, 34(7), 23.
Lucas, L., Khushal, A., Mayes, R., & Couch, B. A. (2025). *Development of the Quantitative Modelling Observation Protocol (QMOP) for undergraduate biology courses: Validity evidence for score interpretation and uses.* International Journal of Science Education, 47(2).
Ma, C., Zeng, H., & Wang, H. X. (2019). *Research on the online and offline hybrid experimental teaching model.* Research & Exploration in Laboratory, 38(5), 185.
Meghan, A. M., Rivka, L. G., & Christne, E. M. (2021). *A creative model for an interdisciplinary approach to service-learning.* Integrative and Comparative Biology, 61(3), 1028–1038.
Mi, G. Q. (2013). *Optimization of the effectiveness of master teacher studios.* Journal of the Chinese Society of Education, 7, 81.
Morrison, J., Raymond, V. (2009). *STEM as a curriculum.* Education Week, 23, 28–31.
Pistilli, M. D., & Arnold, K. E. (2010). *In practice: Purdue signals: Mining real-time academic data to enhance student success.* About Campus, 3, 22–24.
Qiu, X. H. (2024). *High school biology teaching from the perspective of digital literacy.* Biology Teaching, 49(5), 52.
Stern, J. S., et al. (2017). *Tools for teaching conceptual understanding, elementary: Harnessing natural curiosity for learning that transfers.* Corwin, 6, 99.
Xu, Y. (2018). *Exploring the path from artificial intelligence education to educational artificial intelligence.* China Educational Technology, 12, 81–87.

Zhang, Y., Mou, Z. J. (2014). *Educational big data in electronic schoolbags and its applications.* Science Technology and Publishing, 5, 117–119.

.

