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ЗАМАНБАП МААЛЫМАТТЫК ЖАНА КОМПЬЮТЕРДИК ТЕХНОЛОГИЯЛАРГА НЕГИЗДЕЛГЕН БИОЛОГИЯЛЫК КЛАССТА ОКУТУУ МОДЕЛИН ТҮЗҮҮ БОЮНЧА ИЗИЛДӨӨ

Аннотация: Маалыматтык жана компьютердик технологияларды класстык окутууга кеңири интеграциялоо менен, биологияны окутуу көбүнчө фрагменттелген технологияны колдонуудан жана окутуу түзүмүндө системалуу дизайндын жоктугунан жапа чегип келет. Бул кыйынчылыкты чечүү үчүн, маалыматка негизделген окутуу моделдери боюнча эл аралык изилдөөлөрдү системалуу түрдө карап чыгууга негизделген жана биологиянын билим түзүмүн жана окутуу мүнөздөмөлөрүн эске алуу менен, бул макала заманбап маалыматтык жана компьютердик технологиялар тарабынан колдоого алынган биологиялык класстык окутуу моделинин курулуш жолун изилдейт. Изилдөөдө окутуунун объективдүү системаларына, мазмунду уюштурууга, окуу иш-аракеттерин долбоорлоого жана баалоо механизмдерине басым жасаган "максатка багытталган - технология менен колдоого алынган - суроо-талапка негизделген - пикир менен жөнгө салынган" принциптерге негизделген биологиялык класстык окутуу модели сунушталат. Анын иштөө механизми жана окутуунун баалуулугу системалуу түрдө түшүндүрүлөт. Изилдөөдө окутуу моделинин деңгээлинде системалуу долбоорлоо аркылуу гана маалымат жана компьютердик технологиялар биологиялык класстык окутуунун сапатын жакшыртууга натыйжалуу кызмат кыла алат деп айтылат. Бул изилдөө биологияны окутуунун маалыматка негизделген практикасы үчүн структуралык жактан толук жана иштөөчү теориялык алкакты камсыз кылат.

Негизги сөздөр: Биологиялык класстык окутуу; окутуу модели; маалымат технологиясы; компьютердик технология; окутуу түзүмү; суроо-талапка негизделген окутуу; технологиялык интеграция; класстык реформа; окутуу дизайны; билим берүү инновациясы.

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ИССЛЕДОВАНИЕ ПО ПОСТРОЕНИЮ МОДЕЛИ ПРЕПОДАВАНИЯ БИОЛОГИИ В КЛАССЕ НА ОСНОВЕ СОВРЕМЕННЫХ ИНФОРМАЦИОННЫХ И КОМПЬЮТЕРНЫХ ТЕХНОЛОГИЙ

Аннотация: В условиях широкой интеграции информационных и компьютерных технологий в преподавание биологии, обучение биологии часто страдает от фрагментарного применения технологий и отсутствия систематического подхода к структуре обучения. Для решения этой проблемы в данной статье, на основе систематического обзора международных исследований моделей обучения на основе информации и с учетом структуры знаний и особенностей преподавания биологии, исследуется путь построения модели обучения биологии в классе, поддерживаемой современными информационными и компьютерными технологиями. В исследовании предлагается модель обучения биологии в классе, основанная на принципах «целеориентированность — поддержка технологий — исследовательский подход — обратная связь», с акцентом на системы целей обучения, организацию содержания, разработку учебных мероприятий и механизмы оценки. Систематически объясняются ее операционный механизм и педагогическая ценность. В исследовании утверждается, что только посредством систематического проектирования на уровне модели обучения информационные и компьютерные технологии могут эффективно способствовать повышению качества преподавания биологии в классе. Данное исследование предоставляет структурно полную и операциональную теоретическую основу для практики обучения биологии на основе информации.

Ключевые слова: преподавание биологии в классе; модель обучения; информационные технологии; компьютерные технологии; структура обучения; исследовательский подход; интеграция технологий; реформа класса; Разработка учебных материалов; инновации в образовании

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RESEARCH ON THE CONSTRUCTION OF THE BIOLOGY CLASSROOM TEACHING MODE BASED ON MODERN INFORMATION AND COMPUTER TECHNOLOGY

Abstract: In the context of widespread adoption of information and computer technologies in classroom teaching, biology education still faces challenges such as fragmented technology use and the lack of systematic instructional design. Addressing these issues, this study examines the construction of a biology classroom instructional model supported by modern information and computer technologies. Based on a comprehensive review of international research on technology-enhanced instructional models and an analysis of the structural characteristics of biology as a discipline, the paper proposes an integrated instructional model characterized by "goal orientation, technological support, inquiry-driven learning, and feedback regulation." The study elaborates on the core components, operational mechanisms, and instructional value of the proposed model, emphasizing the necessity of embedding technology within the overall instructional structure rather than treating it as an auxiliary tool. The findings suggest that only through systematic instructional model design can information and computer technologies effectively contribute to the improvement of biology classroom teaching quality.

Keywords: biology classroom instruction; instructional model; information technology; computer technology; instructional structure; inquiry-based learning; technology integration; classroom reform; instructional design; educational innovation

I. The Reality Necessity of Problem Setting and Teaching Mode Construction

1.1 The General Dilemma of "Fragmented Technology Applications" in the Context of Educational Informatization

With the increasing integration of information and computer technologies in school education, digital tools have become ubiquitous in classroom instruction. However, extensive international research indicates that technological adoption does not necessarily lead to transformative changes in teaching methodologies. In many educational practices, information technology often functions as a "supplementary tool" —merely overlaying multimedia courseware, video resources, or online platforms onto existing classroom structures—without fundamentally altering instructional organization or learning logic (Kirkwood & Price, 2014). This phenomenon of "fragmented technology application" is particularly pronounced in biology education. Teachers frequently use animations, videos, or virtual experiments during specific instructional segments, yet the overall classroom structure remains linear and teacher-centered. Technology usage remains superficial, failing to be systematically embedded in goal-setting, activity design, or evaluation frameworks. Such an approach not only limits the potential value of technology but also exacerbates teachers' instructional burdens. International studies consistently highlight that when technology lacks systematic pedagogical support, its effectiveness tends to be unstable and unsustainable (Cuban, 2001). Therefore, as educational informatization continues to advance, transitioning from "technology application" to "pedagogical model construction" has become a critical challenge that biology education reform must urgently address.

1.2 The Intrinsic Needs of "Patterned Design" in Biology Classroom Teaching

Compared to other disciplines, biology education demonstrates greater dependence on instructional models in classroom settings. The biological knowledge system exhibits distinct hierarchical structures and internal logic, with complex causal relationships and systemic connections between concepts. Simultaneously, biology instruction emphasizes scientific inquiry processes, requiring more sophisticated approaches to organizing learning activities. Traditional biology classrooms typically follow a "concept explanation—example demonstration—result verification" teaching sequence. While this approach proves effective for straightforward content or clearly defined knowledge points, it often fails to meet students 'comprehension needs when addressing complex mechanisms or systemic issues. Research indicates that students' common difficulties in biology learning stem not from memory limitations, but from inadequate understanding of conceptual relationships and process mechanisms (Michael, 2001). Modern information and computer technologies provide diverse teaching resources and activity formats for biology education, yet these resources can only effectively serve learning objectives within clearly defined instructional frameworks. As a crucial intermediary connecting teaching theory and practice, instructional model development holds fundamental significance for enhancing the overall effectiveness of biology classroom instruction.

1.3 From "Teaching Strategies" to "Teaching Models": A Change in Research Perspectives

In existing international research, discussions on technology-supported biology education often focus on specific teaching strategies or methodologies, such as flipped classrooms, virtual lab instruction, or blended learning. While these studies provide valuable insights into the localized effects of technological applications, they remain insufficient in explaining comprehensive structural changes in classroom teaching. Unlike individual instructional strategies, teaching models are fundamentally about systematically designing relationships between educational objectives, content, activities, and assessments. Joyce et al. (2015) emphasize that teaching models represent holistic arrangements of instructional structures, whose value lies in providing teachers with replicable and adaptable frameworks rather than specific operational steps. In biology education, integrating modern information and computer technologies implies potential transformations in classroom structures, learning activity formats, and teacher-student interactions. Without clear teaching models, such changes may remain superficial and fail to establish stable teaching practices. Therefore, systematically exploring the pathways of information technology integration into biology classrooms through the lens of teaching model development holds significant theoretical and practical value.

1.4 Limitations in Existing Research on Bioinformatics Teaching Models

While international academia has proposed various technology-integrated teaching models—including flipped classrooms, blended learning, and inquiry-based learning—most remain generic interdisciplinary frameworks that lack specificity for biology. Some studies mechanically apply these generic models to biology classes without adequately considering the discipline's knowledge structure and experimental teaching characteristics, resulting in inconsistent implementation outcomes (Means et al., 2013). Furthermore, existing research often focuses on isolated components like pre-class preparation or online discussions, failing to systematically describe the overall classroom dynamics. This "fragmented modeling" approach fails to provide frontline educators with comprehensive, actionable instructional design references.

1.5 Research Objectives and Basic Approach of This Study

Building upon the aforementioned analysis, this study aims to develop a modern information and computer technology-based biology classroom teaching model, grounded in existing international research and tailored to the discipline's pedagogical characteristics. Rather than focusing on technical specifics of software or platforms, the research examines how technology can be systematically integrated into biology instruction through the lens of instructional structure and learning processes. The study's framework comprises three key components: (1) a systematic review of major types of international research on information-based teaching models and their applicability; (2) identification of critical elements for model development aligned with biology's unique pedagogical requirements; and (3) proposal of a structurally sound and practically implementable teaching model framework, which will serve as a theoretical foundation for subsequent instructional practices and empirical research.

II. Analysis of Types of Foreign Information-based Teaching Models and Their Implications for Biology Education

2.1 International Development of Research on Information-based Teaching Models

From an international research perspective, the development of information-based teaching models did not originate from a single discipline, but emerged through the holistic evolution of educational technology. Since the late 20th century, as computer and network technologies entered school education, researchers began systematically integrating technological systems into classroom structures to address the shortcomings of traditional teaching models in learning motivation, deep understanding, and skill development (Cuban, 2001). In the 21st century, research on information-based teaching models gradually shifted from "technology-driven" to "teaching-driven." The focus shifted from the functions of technology itself to how technology restructures the organization of teaching activities and the structure of learning processes (Kirkwood & Price, 2014). Against this backdrop, various technology-supported teaching models have been proposed and tested across different disciplines. Although these models differ in specific forms, they share core principles: emphasizing active learner participation, visualizing learning processes, and structurally designing teaching activities. These characteristics provide valuable references for constructing biology classroom teaching models.

2.2 Flipped Classroom Model and Its Applicability Analysis in Biology Teaching

The flipped classroom, a digital teaching model that has gained significant international traction in recent years, restructures traditional classroom dynamics by moving knowledge delivery to pre-class preparation while dedicating in-class time to discussions, explorations, and problem-solving (Bishop & Verleger, 2013). In biology education, this approach demonstrates notable advantages. First, the subject's extensive conceptual content is well-suited for self-directed learning through videos and digital resources. Second, classroom time can be allocated to experimental discussions, case analyses, and inquiry-based activities, thereby enhancing student engagement and deepening comprehension. Research indicates that implementing flipped classrooms in biology and medical-related courses improves learning attitudes and classroom interaction levels (McLaughlin et al., 2014). However, studies also highlight that flipped classrooms may not yield significant benefits in all contexts. Without clear instructional design and learning support, students may experience cognitive overload or insufficient engagement during pre-class preparation. Therefore, adapting this model to biology education requires tailored adjustments based on the discipline's unique characteristics.

2.3 Application Characteristics of Blended Learning Model in Biology Classrooms

Blended learning, another widely discussed digital teaching model in international research, emphasizes the organic integration of online learning and offline classroom instruction. By combining the strengths of different learning environments, it enhances teaching flexibility and learning outcomes (Means et al., 2013). In biology education, this model is commonly used to integrate theoretical learning with experimental teaching. Online platforms provide background knowledge, extended resources, and formative assessments, while offline classes focus on hands-on experiments and in-depth discussions. Studies show that blended learning often yields more consistent learning outcomes in biology courses compared to single-form teaching methods (Bernard et al., 2014). However, it's important to note that blended learning alone doesn't constitute a complete teaching model. Its effectiveness heavily depends on the coordination between online and offline activities.

Without comprehensive design, online learning and classroom instruction may become disconnected, undermining the model's advantages.

2.4 Technical Support Pathways for Inquiry-Based and Problem-Oriented Learning Models

Inquiry-based learning and problem-based learning are key pedagogical approaches in science education. With the advancement of information technology, these models have been increasingly integrated with digital tools, forming technology-supported inquiry-based learning. In biology education, such technology-enhanced inquiry learning primarily manifests through virtual experiments, data analysis tools, and online collaborative platforms. Research indicates that computer simulations and virtual experiments provide students with opportunities to explore complex biological processes, demonstrating particular advantages in scenarios with limited experimental resources (Smetana & Bell, 2012). However, international studies also highlight that inquiry-based and problem-oriented learning demand high-level instructional design skills from educators. Without proper guidance and structured support, students may become disoriented during the inquiry process, potentially compromising learning outcomes (Hmelo-Silver et al., 2007).

2.5 Comparison and Comprehensive Analysis of Different Information-based Teaching Models

The analysis reveals that while current digital teaching models emphasize different aspects in their conceptual frameworks and structural designs, none have developed a highly customized framework specifically tailored to biology's unique characteristics. Some models focus on restructuring classroom dynamics, others prioritize integrating learning environments, and still others highlight supporting inquiry-based processes. However, in practice, these approaches often exhibit the characteristic of being "locally effective but holistically inadequate."

Table 2-1 Comparison of Characteristics of Typical Overseas Information-based Teaching Models

model of instruction	Core features	The Enlightenment of Biology Teaching	Main limitations
flipped classroom	temporal structure reorganization	Free up classroom inquiry time	High dependence on pre-class learning
Blended Learning	Online and offline integration	Support the integration of experiment and theory	Prone to tearing
inquiry-based learning	Emphasize the problem and explore	Promote scientific thinking	High design difficulty

2.6 Implications for the Construction of Biological Classroom Teaching Models

A systematic analysis of international information-based teaching models demonstrates that no single approach can fully address the multifaceted demands of biology education. Therefore, it is essential to develop a comprehensive teaching model that integrates the strengths of various approaches while aligning with the unique characteristics of biology. This study proposes that the design of biology classroom teaching models should prioritize the following aspects: First, the model should center on the knowledge structure of biology rather than being technology-driven. Second, the design should emphasize structured learning activities to guide students in gradually building an understanding of life systems. Third, information and computer technologies should serve as tools for inquiry and feedback, embedded throughout the teaching process. These insights lay the foundation for proposing a specific framework of biology classroom teaching models in the subsequent section.

III. Construction of a Modern Information and Computer Technology-Based Teaching Model for Biology

3.1 Basic Principles and Theoretical Basis of Teaching Model Construction

The development of bio-education classroom models supported by information and computer technology should not be reduced to mere technological integration or rearrangement of instructional components, but must be grounded in well-defined pedagogical principles and theoretical foundations. International research on instructional models consistently emphasizes that their effectiveness depends on establishing stable and coherent internal logical relationships among teaching objectives, content, learning activities, and assessment (Joyce, Weil, & Calhoun, 2015). Building upon the analysis of global digital teaching models and the inherent knowledge structure of biology, this study proposes three fundamental principles for constructing information-based bio-education models. First, subject-oriented approach: Technology selection and application must align with biological knowledge logic and learning objectives, rather than allowing technological formats to dictate instructional structures. Studies indicate that technology implementations ignoring disciplinary characteristics often lead to ambiguous teaching goals and inconsistent learning outcomes (Koehler & Mishra, 2009). Second, structural integrity: Instructional models should encompass the entire teaching process—including goal setting, content organization, activity design, and evaluation feedback—rather than focusing solely on specific components. Incomplete models struggle to maintain practical implementation. Third, process visualization: The strengths of information and computer technology lie in their capacity to document and present learning processes. An effective teaching model should fully leverage this advantage to make students' learning activities and cognitive processes observable and controllable (Siemens & Long, 2011). These principles collectively form the theoretical foundation for constructing a biology classroom teaching model in this paper.

3.2 Core Components of the Biological Classroom Teaching Model

Based on established construction principles, it is essential to define the core components of teaching models. Integrating international research findings on teaching models with the characteristics of biology education practice, this paper categorizes the information-based biology classroom teaching model into four interconnected core elements: the teaching objective system, the teaching content system, the learning activity system, and the teaching evaluation system. First, the teaching objective system serves as the starting point of the teaching model. In the context of information technology, biology teaching objectives should transcend mere knowledge acquisition, emphasizing the development of scientific inquiry skills, systematic thinking abilities, and problem-solving capabilities (National Research Council, 2012). Clarifying teaching objectives helps teachers maintain consistent direction in technology selection and instructional design. Second, the teaching content system forms the foundation of the teaching model's operation. Biology teaching content should be modularized according to knowledge structure and learning difficulty, with dynamic presentation achieved through information technology. Research indicates that reorganizing biological knowledge through conceptual hierarchy and process logic facilitates students' formation of more stable cognitive structures (Michael, 2001). Third, the learning activity system constitutes the core component of the teaching model. Information and computer technologies enable diverse learning activities, including virtual experiments, problem scenario simulations, online collaboration, and data analysis. These activities should revolve around clearly defined questions and maintain high consistency with teaching objectives (Hmelo-Silver et al., 2007).

Fourth, the teaching evaluation system is a crucial mechanism to ensure the effective operation of teaching models. Informatized teaching evaluation should not merely focus on outcome measurement but should also utilize process data to support formative assessment, thereby providing a basis for teaching adjustments and student self-reflection (Black & William, 1998).

3.3 Structural Framework of Bio-classroom Teaching Model Based on Information and Computer Technology

Building upon these foundational elements, this study proposes a "goal-oriented—technology-supported—inquiry-driven—feedback-regulated" instructional framework for biology classrooms. The model emphasizes the embedded integration of information and computer technologies across multiple teaching phases rather than isolated application in single stages. During the preparation phase, educators conduct systematic analysis of biological content based on instructional objectives, utilizing digital tools to develop learning resources and contextualized problem scenarios. This phase primarily establishes cognitive foundations for classroom inquiry activities. In the implementation phase, learning activity systems become the core of instructional execution. Teachers facilitate inquiry-based learning through guided questioning, virtual experiments, and data analysis. Information and computer technologies primarily serve to support inquiry and enhance interactive engagement during this stage. In the evaluation phase, assessment systems comprehensively evaluate students' learning processes and outcomes through digital platforms and tools. The evaluation results not only determine learning effectiveness but also provide feedback on instructional design rationality, thereby forming a closed-loop system for teaching improvement.

Table 3-1 Structure of Biological Classroom Teaching Model Based on Information and Computer Technology

teaching stage	Core Task	Technical support method	Teaching Function
teaching preparation	Structured Objectives and Content	Digital resources and platforms	constructive learning situation
Classroom Implementation	Explore and interact	Simulation and collaboration tools	Promote deep learning
teaching evaluation	process and result feedback	data analysis system	Control and Improvement

3.4 Operational Mechanism and Intrinsic Logic of Teaching Models

From a pedagogical perspective, this teaching model operates not as a linear process but as a dynamic cyclical system. Teaching objectives guide instructional activities, while learning activities are implemented with technical support. Evaluation results then inform the refinement and adjustment of teaching objectives. This cyclical mechanism enhances the adaptability and stability of the teaching model. International research indicates that teaching models with feedback control mechanisms are more effective in complex teaching scenarios (Hattie, 2009). This is particularly crucial in biology education, where students demonstrate significant variations in understanding different biological concepts, requiring teaching models to maintain flexibility.

3.5 The Innovative Significance of This Teaching Model Compared with Existing Models

Unlike conventional digital teaching models like flipped classrooms or blended learning, the proposed biology teaching model in this paper transcends simple adaptation of existing approaches. It establishes a comprehensive framework centered on biology's unique characteristics by synthesizing the strengths of multiple methodologies. The model's innovative value is demonstrated in three key aspects: First, it prioritizes disciplinary knowledge structure over indiscriminate technology application. Second, it positions learning activity systems as the core of instructional design, fostering deep learning. Third, through an evaluation and feedback mechanism, it enables continuous optimization of the teaching process.

IV. Operational Effectiveness, Teaching Value and Practical Implications of the Teaching Model

4.1 Comprehensive Impact of Teaching Model Operation on the Structure of Biology Classroom Instruction

The implementation of the "goal-oriented — technology-supported — inquiry-driven — feedback-regulated" digital biology teaching model has brought about significant transformations in classroom dynamics. Unlike traditional teacher-centered instruction with linear progression, this framework restructures learning into a multi-stage system through technological integration. The model redefines instructional timelines by extending beyond conventional class periods to include pre-class preparation, in-class exploration, and post-class consolidation. During pre-class preparation, students utilize digital resources to grasp foundational concepts; in-class sessions focus on problem-solving and conceptual deepening; while post-class reflection and feedback reinforce learning outcomes. This structural shift not only optimizes classroom time allocation but also creates conditions for deep learning (Bishop & Verleger, 2013). Furthermore, the model emphasizes interactive learning activities driven by problem-solving tasks. Digital technologies enable diverse engagement methods—such as online collaboration, real-time feedback, and data sharing—transforming one-way teacher-student interactions into dynamic networks. This evolution significantly enhances student participation and learning engagement (Hattie, 2009).

4.2 Impact on Students' Learning Process and Experience

From the learner's perspective, this teaching model has multifaceted impacts on students' learning processes and experiences. International research consistently indicates that technology-enhanced instruction can improve students' attitudes toward biology learning and boost motivation (Means et al., 2013). Within this framework, learners enjoy greater autonomy. Through digital platforms, students can revisit learning materials at their own pace and proactively choose research paths during inquiry-based activities. This autonomy helps students develop a sense of control over their learning journey, thereby strengthening motivation. Furthermore, tools like dynamic visualization and virtual experiments make abstract biological concepts more tangible, reducing comprehension barriers. Studies show that when students observe and manipulate biological processes in digital environments, they achieve deeper conceptual understanding and more positive learning experiences (Mayer, 2009; Smetana & Bell, 2012).

4.3 The Influence of Teaching Model on Teachers' Teaching Behavior and Professional Development

This teaching model has not only transformed students 'learning approaches but also significantly influenced educators' instructional practices and professional development. As the model evolves, teachers transition from knowledge transmitters to active designers and facilitators of learning activities. This role shift requires educators to systematically plan teaching objectives and learning activities beforehand. Research in teacher education abroad indicates that professional growth in digital teaching environments is closely tied to instructional design capabilities and technology integration skills (Koehler & Mishra, 2009). Within this framework, teachers must select appropriate technological tools tailored to biology's unique characteristics and integrate them into teaching practices. This process encourages educators to reflect on both content delivery and teaching methodologies, thereby fostering professional development. Meanwhile, learning process data from assessment systems provide teachers with evidence-based insights to evaluate instructional effectiveness. By analyzing students' performance across different learning stages, educators can refine their teaching strategies with greater precision, enhancing instructional relevance.

4.4 Teaching Value and Educational Significance of Teaching Model

From the perspective of educational value, this model demonstrates positive implications across multiple dimensions. Firstly, it provides a well-structured and logically coherent framework for biology classroom instruction, enabling teachers to systematically integrate information technology resources while avoiding arbitrary and fragmented application of technology. Secondly, the model facilitates the transition of biology education from knowledge-oriented to competency-oriented approaches. Through inquiry-based learning and formative assessment, students gradually develop scientific thinking and problem-solving skills during the learning process, which aligns closely with the goals advocated by international science education reforms (National Research Council, 2012). Thirdly, from the perspective of educational equity, the information technology-supported teaching model helps alleviate disparities in educational resources. By enabling digital resource sharing, students across different schools and regions can access relatively consistent learning support, thereby narrowing educational gaps to some extent.

Table 4-1 Main Teaching Values of Teaching Mode Operation

bedding	embody	pedagogical meaning
structure of teaching	systematization of classroom organization	Enhance teaching stability
learning process	Exploration and Feedback	Promote deep learning
Teacher Development	Enhancing Design and Reflection Skills	Promote professional growth

4.5 Practical Conditions and Implementation Suggestions for Teaching Mode Application

While this teaching model demonstrates theoretical merits and practical potential, its successful implementation requires specific conditions. First, schools must establish essential IT infrastructure and technical support to ensure smooth teaching operations. Second, educators need systematic digital pedagogy training to enhance their skills in technology integration and instructional design. For implementation, teachers should adopt a phased approach: piloting the model in select teaching units to accumulate experience before scaling up. Additionally, continuous teaching reflection and peer collaboration are crucial to refine the model's adaptability and effectiveness through ongoing improvement.

V. Conclusion and Application Prospects

5.1 Main Research Findings

Building on systematic reviews of international research on information-based teaching models, this study explores the development of modern biology classroom instruction by examining how information and computer technologies can be systematically integrated into teaching practices. The research demonstrates that merely introducing technical tools does not substantially improve teaching quality. Only through systematic design of instructional frameworks can the full potential of information and computer technologies be realized in biology education.

First, from the perspective of instructional structure, information and computer technology provide technical conditions for transforming biology classrooms from a "linear lecture structure" to a "multi-stage, cyclical learning structure". By organically integrating pre-class preparation, in-class exploration, and post-class feedback, classroom teaching is no longer confined to a single time-space framework but forms a continuous, dynamic learning process. This structural transformation helps improve the efficiency of classroom time utilization and creates necessary conditions for deep learning. Second, from the perspective of teaching functions, the informatized teaching model strengthens the core position of "exploratory activities" in biology classrooms. Virtual experiments, situational simulations, and data analysis tools enable students to explore complex life processes in a safe and controllable environment, thereby deepening their understanding of biological concepts and mechanisms. This change drives biology teaching to transition from knowledge presentation to problem-solving and scientific inquiry. Third, from the perspective of teaching regulation, evaluation and feedback mechanisms supported by information and computer technology make the teaching process more visual and controllable. Through continuous collection and analysis of learning process data, teachers can more accurately grasp students' learning status and adjust teaching strategies accordingly. This data-driven teaching regulation approach helps enhance the scientific nature of teaching decisions.

5.2 Theoretical Significance of Teaching Model Construction

Theoretically, this study expands the analytical perspective of information-based teaching research. While existing studies predominantly focus on evaluating the effectiveness of technical tools or specific instructional strategies, this paper situates information and computer technologies within the broader framework of instructional model development, emphasizing the systemic connections between teaching objectives, content, learning activities, and assessment. By incorporating instructional model theory and technology integration perspectives, the study provides a structural explanation for understanding how technology functions in subject-specific teaching. This interpretive approach helps overcome the prevalent "instrumentalism" tendency in information-based teaching research, offering a more integrated theoretical framework for future studies. Furthermore, by taking biology as the research subject, the paper adapts general information-based teaching models to disciplinary contexts, enriching the theoretical depth of subject-specific instructional model research. This methodology also holds significant reference value for other experimental and systemically complex subject teaching research.

5.3 Application Value in Biological Teaching Practice

At the practical level, the teaching model proposed in this paper provides an actionable pathway for reforming biology classroom instruction. By clarifying instructional structures and operational mechanisms, this model enables teachers to systematically integrate information technology resources in actual teaching practices, avoiding arbitrary and fragmented technology application. For frontline biology teachers, the model emphasizes selecting technical tools based on teaching objectives and learning activities, which helps reduce the implementation threshold of digitalized teaching. Meanwhile, by incorporating evaluation and feedback mechanisms into the teaching model, educators can continuously reflect on and optimize instructional designs during the teaching process, thereby enhancing teaching quality. From a school-level perspective, this model offers a comprehensive design framework for digitalized teaching reform, helping educational administrators align technological investments with teaching reform goals when advancing educational informatization, avoiding the pitfall of pursuing hardware construction at the expense of teaching effectiveness.

5.4 Practical Conditions and Applicable Boundaries for the Promotion of Teaching Models

It should be noted that the effective implementation of any teaching model depends on specific practical conditions. The information and computer technology-supported biology classroom teaching model is also constrained by factors such as technical conditions, teachers 'professional capabilities, and students' learning characteristics. Firstly, in terms of technical conditions, the implementation of the teaching model requires basic information infrastructure and technical support environments. Secondly, at the teacher level, the operation of the model imposes higher demands on teachers 'instructional design capabilities and technical integration skills, with their professional development levels directly impacting the model's effectiveness. Thirdly, at the student level, differences in adaptation to information-based learning environments among students at different learning stages and backgrounds determine the specific application methods of the model. Therefore, when promoting this teaching model, it is essential to fully consider the diversity of educational contexts and avoid a "one-size-fits-all" approach. It is recommended to adopt a phased and modular application strategy in actual teaching, flexibly adjusting the model structure based on specific teaching objectives and conditions.

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