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Analysis of Teaching Reform in *Zoology Experiment* Courses at Normal Universities Using Micro-video Instructional Models

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Abstract With the deep advancement of modern educational informatization, the micro-video teaching model has gradually become an effective approach for promoting the innovation and reform of experimental teaching, owing to its advantages such as intuitive visualization, repeatability, and flexible learning. This paper addressed the limitations of the traditional zoology experiment teaching model, which include insufficiently clear teacher demonstrations, limited class time, and the difficulty of accommodating individual student differences. Accordingly, we systematically analyzed the main characteristics, implementation models, and effectiveness of the micro-video teaching model in the *Zoology Experiment* course. We also discussed the primary challenges encountered during its teaching practice and proposed corresponding recommendations for improvement. This analysis aimed to provide a theoretical reference for the teaching reform of *Zoology Experiment* in normal universities.

Key words Micro-video teaching; *Zoology Experiment*; Normal education; Teaching reform

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In recent years, the nation has attached great importance to the cultivation of normal students (preservice teachers)[1]. In August 2024, a strategic requirement was clearly articulated to promote the spirit of educationists and build a high-quality, professional teacher workforce[2]. As a fundamental course for practical teaching, the *Zoology Experiment* course plays a crucial role in fostering the scientific literacy, practical ability, and teaching skills of normal students. Practical teaching is being placed in an increasingly central position in the field of international science education, with its critical role in cultivating students' comprehensive scientific literacy being widely emphasized. For instance, in U.S. science curricula, the predominant instructional model integrates ecological environments and human activities, with a focus on guiding students toward independent inquiry, data processing, and conclusion construction[3]. The United Kingdom, in contrast, emphasizes linking experiments to real life to facilitate the integration of theory and practice[4].

However, traditional *Zoology Experiment* teaching in China is predominantly instructor-led, leaving students in a mostly passive receptive state[5], resulting in a notable deficiency in the development of independent inquiry and practical skills. Under this model, teacher demonstrations are often restricted by space and viewing angle, making observation difficult for students in the back rows. Insufficient class time makes it challenging to ensure the effective completion of detailed dissection experiments. Moreover, the lack of personalized guidance prevents teachers from adequately attending to the operational details of multiple groups of students[6]. Additionally, subtle anatomical structures are difficult to display clearly due to the limited visual range of live demonstrations[7]. With the rapid development of modern information technology, the micro-course (or micro-video) teaching approach has emerged. This model is characterized by short duration, high efficiency, and supports both fragmented and personalized learning. The development and integration of such informational resources have become an important pathway to enhance the effectiveness of biology experimental instruction[8].

Biology normal students represent the future teaching staff for primary and secondary school biology. Their professional development requires a shift from merely "teaching a lesson well" to "developing a course". For them, the *Zoology Experiment* course should not only impart experimental skills but also cultivate their ability in instructional design and implementation, thus laying a foundation for their future careers in biology education[9-10]. Leveraging its features of visualization, repeatability, and fragmented learning, the micro-video teaching model uses concise video resources to intuitively present experimental procedures. This effectively overcomes spatiotemporal constraints and meets the instructional demands of the digital age[6,11]. This paper aimed to systematically

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analyze the characteristics and practical effects of the micro-video teaching model within the *Zoology Experiment* course in normal universities, with a particular focus on its impact on the cultivation of normal students' professional competence. This work is intended to serve as a reference for experimental teaching reform and the professional development of normal students in normal institutions.

Theoretical Foundation and Characteristics of the Micro-video Teaching Model in Normal Education

Concept and development of micro-video teaching

Micro-video teaching is a modern instructional method that utilizes short, concise videos to deliver instruction focusing on specific knowledge points or skill sets[6,8,12]. This approach originated with open courses at the Saint Ignatius College in New Mexico, USA, and subsequently gained global traction[12]. In recent years, micro-video teaching has developed rapidly in China, showing significant potential, especially in the field of experimental instruction.

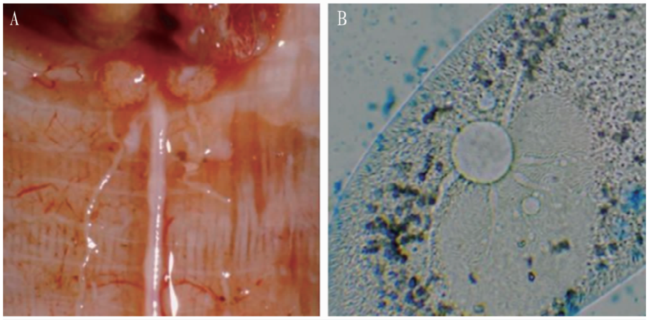
In normal education (normal student training), the micro-video serves not only as a learning tool but also as a pathway for cultivating the normal students' future instructional competence. By participating in the processes of micro-video learning and production, normal students can simultaneously master both subject-specific experimental skills and modern educational technology application abilities. This facilitates a crucial role shift from knowledge recipient to curriculum designer and implementer, laying a solid foundation for them to undertake systematic teaching tasks in the future[9].

Characteristics of the micro-video teaching model in normal universities

The micro-video teaching model exhibits multifaceted structural features within normal universities, with its core advantages lying in the miniaturization of content design, autonomy of the learning process, diversification of resource formats, and professionalization of pedagogical development. The model typically limits video duration to 5 to 10 min, focusing on core knowledge segments[9]. It aligns with the principles of cognitive load theory, effectively boosting the efficiency of knowledge absorption[13]. Regarding the learning modality, the model supports students in autonomously selecting their study time and location, enhancing the personalized learning experience. The resource composition of micro-videos features a multimodal integration, organically combining video, animation, graphics, and text. This effectively broadens the pathways for representing and disseminating instructional information, which aids students in deepening their comprehension of experimental procedures and systematically guiding them to master teaching implementation skills. This, in turn, helps establish a solid foundation for them to become high-quality biology teachers[9-10,14].

Potential Implementation Models of Micro-videos in the Teaching of *Zoology Experiment*

In the teaching of *Zoology Experiment*, the traditional model faces multiple constraints, such as poor visibility of demonstrations, obscuring of operational details, and limited class time, which restrict the effective cultivation of normal students' experimental operation and instructional abilities[6]. The introduction of micro-videos offers an effective solution to these issues. Operation Demonstration Videos: These videos use close-up shots and step-by-step demonstrations to focus on key experimental skills, enhancing the visibility and detail presentation of the procedures. For instance, in the earthworm dissection, a video can clearly illustrate the technique for opening the coelom and the appearance of microscopic structures like the ovaries (Fig. 1A). Phenomena Observation Videos: These are capable of capturing and presenting microscopic or transient biological phenomena, helping students accurately grasp complex theoretical content. In a *Paramecium* observation experiment, structures like food vacuoles and contractile vacuoles are often difficult to observe due to the challenge of capturing the precise moment. Through videos on protozoa observation, students can repeatedly review the dynamic processes of various organelles (Fig. 1B), effectively overcoming the timing issues encountered during real-time observation.



A: Schematic diagram illustrating the structure of the female reproductive organs of the earthworm. B: Schematic diagram illustrating the structure of the contractile vacuole (collecting tubule) in *Paramecium*.

Fig. 1 Partial content display of zoology experimental videos

In our practical implementation of *Zoology Experiment* teaching, we have systematically recorded a series of operational videos for typical experiments, including "*Paramecium* Observation", "Earthworm Dissection", and "Pigeon Dissection", progressively building a micro-video resource system that is clearly categorized and content-focused (Table 1). This system covers three main types: observation-based experiments, invertebrate dissection, and vertebrate dissection, spanning the entire process from basic observation to complex dissection. The video content emphasizes the presentation of dissection procedures, structure identification, and microscopic morphology, with durations kept within 3 – 15 min to conform to the cognitive principles of micro-learning. Crucially, the videos organically integrate professional competence elements for normal students, such as experiment preparation, operational standards, and instructional expression. Evidently, micro-video resources provide significant support for the development of their teaching abilities. For normal students, this teaching model further requires them to independently design micro-videos or experiment teaching plans suitable for secondary school students, based on the learned experimental content. This systematic approach cultivates their experimental skills, pedagogical practical ability, and information technology application skills[9,10,15]. By deepening normal students' understanding of experimental teaching content, it better facilitates their shift from "learning how to perform an operation" to "learning how to teach the operation", thereby establishing a solid foundation for their future professional development.

Table 1 Types and content of *Zoology experiment*al micro-video resources

Experimental Organisms	Video Content Focus	Targeted Experimental & Pedagogical Skills
Paramecium	Preparation of temporary slides, stress response, and the formation and movement of food vacuoles.	Experimental Preparation and Organizational Skills
Earthworm	Anesthesia handling, external morphology observation, dorsal incision technique, observation of organ systems, and exposure of the female reproductive and nervous systems.	Dissection Techniques, Fine Motor Skills, and Structure Identification
Mussel	Observation and identification of external structures, shell opening technique, separation of the mantle, observation of organ systems, and identification of the gonads and nerve ganglia.	Fine Motor Skills, Structure Identification, and Explanation (Pedagogical)
Swamp shrimp	Separation of appendages, cephalothorax dissection, exposure of the gill chamber, and identification of various system organs.	Dissection Techniques, Structure Identification, and Explanation (Pedagogical)
Locust	External observation, sex identification, separation of appendages, identification and separation of mouthpart structures, identification of various system organs, and complete removal of the reproductive and digestive systems.	Dissection Techniques, Fine Motor Skills, and System Explanation (Pedagogical)
Crucian Carp	External observation, scale formula calculation, abdominal cavity exposure, identification of the swim bladder duct, identification of various system organs, and technique for brain tissue exposure.	Dissection Techniques, Fine Motor Skills, and Structure Recognition
Bullfrog	External observation, double-pithing method, skinning (skin peeling), identification of various system organs, and technique for nervous system exposure.	Complex Dissection Techniques and Step-by-Step Instruction (Pedagogical)
Pigeon	Feather handling, pectoral muscle separation, observation of the air sac system, observation of various system organs, and technique for brain tissue exposure.	Dissection Techniques, Structure Recognition, and Explanation of Adaptive Features (Pedagogical)

Analysis of Implementation Effects of Micro-video Teaching in Normal Student Training

Enhancement of normal students' experimental operation and pedagogical abilities

In *Zoology Experiment* teaching, the application of micro-videos as an instructional tool integrating modern information technology shows significant potential for cultivating normal students' experimental operation and teaching skills[14]. Studies indicate that the micro-video teaching model effectively addresses various challenges inherent in traditional experimental instruction and has achieved notable success in animal experiments[11,15]. A survey of 56 students, for instance, revealed that 94% considered micro-video instruction an effective solution to problems in experimental teaching[11]. Furthermore, micro-video instruction provides crucial support to zoology experiments through its features of visualization, repeatability, and fragmentation. In operation demonstration videos, key technical details are highlighted, effectively improving students' operational standardization and experimental completion quality[15]. Such resources not only help students understand complex dissection procedures and microscopic morphology but also potentially reduce the use of laboratory animals, signifying its positive impact on educational ethics and resource optimization[16]. After integrating micro-video instruction into *Zoology Experiment* at a traditional agricultural university, the average score in student experimental assessments increased by over 12 points compared to the traditional model, effectively improving students' mastery of knowledge points and technical essentials[6].

For normal students, the value of micro-video teaching extends beyond the acquisition of experimental skills to encompass the cultivation of their instructional design and implementation abilities. By participating in the processes of dissection practice, micro-video production, and teaching practice, students can better comprehend the key points and challenges of experimental teaching while mastering the application of modern educational technology[9,15]. This process facilitates their crucial transition from "learning how to perform an experiment" to "learning how to teach the experiment", laying a solid foundation for their future professional careers[15,17]. Evidently, the micro-video teaching model has broad application prospects in the teaching of *Zoology Experiment* within normal universities, as it can both enhance instructional effectiveness and systematically promote the synergistic development of normal students' operational skills and pedagogical literacy.

Comprehensive development of normal students' professional literacy

The micro-video teaching model significantly enhances normal students' autonomous learning ability, practical operation skills, and scientific thinking capacity[13]. Supported by this model, normal students gradually shift from passive imitation to active inquiry, enabling them to deeply understand relevant principles and operational essentials before conducting experiments, and to exhibit stronger critical thinking and innovation awareness during the process. Furthermore, micro-video instruction contributes to the cultivation of normal students' comprehensive pedagogical literacy. By analyzing and evaluating the instructional design strategies embedded within the micro-videos, normal students can better understand teaching principles and methods, thereby improving their curriculum design and classroom implementation skills[10,15]. Meanwhile, through involvement in the shooting and editing processes of micro-videos, normal students can progressively master the application techniques of modern educational technology, enhancing their information literacy and instructional resource development capabilities, which is crucial for adapting to future informatized teaching environments [9,15].

Improvement of experimental teaching efficiency and safety

The micro-video teaching model demonstrates notable advantages in improving experimental teaching efficiency[9], primarily through the optimization of instructional procedures and the reduction of burden on both teachers and students. On one hand, by front-loading basic operational explanations into the video learning segment, the model effectively shortens the time required for fundamental instruction in the classroom, thereby reserving more time for students' actual hands-on practice and interactive inquiry. On the other hand, leveraging micro-videos' characteristics of repeatable viewing and self-paced learning, students can reinforce learning in weak areas. This not only reduces reliance on teacher's individual guidance but also enhances the goal-orientation and initiative of their learning[6,12,16].

Notably, the application of micro-videos in experimental teaching also offers added value in terms of teaching safety and environmental improvement. Especially in animal dissection experiments, the long-standing issue of irritants such as ether and formaldehyde poses a potential threat to the health of teachers and students. Video-assisted instruction can replace the direct demonstration of traditional wet specimens in some segments, thereby reducing the exposure of both groups to harmful substances and significantly improving the quality of the laboratory environment. This not only provides an effective path for resolving irritant-related issues but also subtly cultivates students' awareness of laboratory safety and preliminary management skills, reflecting the dual significance of micro-video teaching in technological integration and humanistic care.

Challenges and Countermeasures for Micro-video Teaching in Normal Universities

With the deepening advancement of educational informatization, micro-video teaching has become a crucial means for the teaching reform of *Zoology Experiment* in normal universities. However, its application within the context of normal student training still faces several unique challenges, which necessitate the adoption of targeted strategies. Challenge of Fostering Dual Competency Integration in Normal Students: In normal universities, micro-video instruction is tasked with the dual mission of not only improving normal students' experimental operational skills but also cultivating their instructional design and implementation abilities[9,10]. This dual requirement poses more specialized and systematic challenges to micro-video content construction and pedagogical strategies. Countermeasure: Pedagogical guidance should be integrated into the micro-videos to help normal students understand how to apply the relevant experiments and techniques in secondary school biology teaching. High Professional Requirements for Video Production: The production of micro-videos for zoology experimental dissections requires specialized shooting equipment and technical support for showcasing microscopic operations and anatomical structures. Countermeasure: Institutions can collaborate with information technology majors to establish interdisciplinary production teams, introducing high-definition micro-cameras and 3D animation simulation techniques to enhance the professional quality of video production. Meanwhile, normal students should be encouraged to collaborate with students from relevant majors in the micro-video production process to cultivate their educational technology application skills while addressing the human resources and high professionalism required for video creation. Variability in Students' Autonomous Learning Ability: Students exhibit significant differences in their ability to learn independently, with some having weaker self-learning skills, which affects the effectiveness of video-based learning[6,10]. Countermeasure: Teachers can adopt a stratified task design strategy, adding guiding questions to provide personalized learning support and guidance for students with different foundational levels. Furthermore, cooperative group learning can be utilized to facilitate mutual assistance and guidance among students[18]. The Seamless Transition from Video Learning to Practical Operation: Some students are viewers of videos but remain clumsy in actual execution[6]. Countermeasure: It can be addressed by increasing virtual simulation training and phased skill practice to help students bridge the gap between video observation and practical application. For normal students, the micro-teaching method can be employed to allow them to repeatedly practice experimental operation and explanation, thereby improving their instructional implementation capabilities. Challenge of Instructional Resource Sustainability: The development of high-quality micro-video resources requires continuous investment of significant time and professional technical expertise. Countermeasure: At the institutional level, digital resource platforms can be integrated to build a modular, reusable new-form textbook resource repository. Additionally, establishing an inter-institutional resource-sharing mechanism through collaboration can enhance resource utilization efficiency and ensure the continuous updating and optimization of micro-video instructional resources. In summary, the application of micro-video teaching in normal universities requires a multifaceted approach, utilizing strategies such as technological innovation, optimization of instructional design, and collaborative resource construction and sharing to overcome implementation challenges and continuously enhance the quality of zoology experimental instruction.

Conclusions and Future Perspectives

The micro-video teaching model has demonstrated significant advantages in the *Zoology Experiment* course at normal universities. By leveraging its characteristics of visualization, repeatability, and fragmented learning, it has effectively addressed traditional experimental teaching issues such as limited demonstration quality, insufficient class hours, and a lack of personalized guidance. Research indicates that this model not only improves normal students' experimental operation standardization and success rate but also significantly contributes to the cultivation of their instructional design and implementation abilities, promoting the comprehensive development of their professional literacy[6].

To further enhance the effectiveness of micro-video teaching and deepen its application, future development should focus on the following four areas. Strengthening Resource Development with Normal University Characteristics: A dual-content system that integrates both experimental operation and pedagogical guidance should be constructed. This system should cover key skills and teaching essentials in *Zoology Experiment*, supporting the entire developmental process of normal students from experimental performance to instructional transformation[13-14]. Promoting Technological Integration and Innovation: It is crucial to actively introducing technologies such as Virtual Reality (VR), Augmented Reality (AR), and Artificial Intelligence (AI). These can create highly authentic experimental environments for students, thereby enhancing their learning experience and instructional effectiveness[19-22]. Deepening Research on Normal Student Competency Development: It is necessary to explore the pathways through which micro-videos influence teaching and experimental abilities, and optimize the training routes for normal student competency. Establishing Inter-Institutional Collaboration and Resource Sharing Mechanisms: The sharing and collaborative development of micro-video resources should be promoted among normal universities to improve the quality and utilization efficiency of micro-video resources.

In conclusion, the micro-video teaching model offers an effective pathway for the teaching reform of *Zoology Experiment* in normal universities. It not only elevates the effectiveness of experimental teaching but also facilitates the comprehensive development of normal students' professional competencies. With the continuous advancement of educational informatization, micro-video instruction is poised to play a vital role in training high-quality biology teachers.

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