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The Integration and Practical Exploration of Information-based Teaching Methods in Vocational Education of Medical Laboratory Technology

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Abstract: Against the backdrop of the rapid intelligent development of medical laboratory technology, vocational education is in urgent need of teaching innovation. This paper explores the integration and practice of information-based teaching methods in vocational education of medical laboratory technology, analyzes the current situation of traditional teaching and the demand for informatization, and elaborates on the practical paths from aspects such as resource construction, model innovation, and evaluation reform. Practice has verified that this integration has improved teaching quality and students' skills, but there are problems such as uneven resources and the need to improve teachers' and students' abilities. Countermeasures such as strengthening co-construction and sharing of resources and carrying out special training are proposed to provide reference for the development of professional education.

Keywords: Information-based teaching; Medical laboratory technology; Vocational education; Teaching integration; Practical exploration

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1. Core theoretical basis

Constructivist learning theory emphasizes that students acquire cognition through active exploration and knowledge construction, which is in line with the learning needs of complex operational skills and theoretical knowledge in vocational education of medical laboratory technology. Information-based teaching methods, with the help of technologies such as virtual simulation and interactive platforms, create immersive learning situations for students, prompting them to complete knowledge internalization in simulated real work scenarios [1]. Blended learning theory advocates the organic integration of online learning and offline teaching. It uses digital resources such as micro-lectures and MOOCs to advance theoretical learning, while class time focuses on practical guidance and problem-solving, achieving a dual improvement in teaching efficiency and quality.

Situated cognition theory holds that the acquisition and application of knowledge are inseparable from specific contexts. As a highly practical major, medical laboratory technology can restore clinical laboratory work scenarios relying on virtual laboratories and case databases built by information-based means, helping students transfer theoretical knowledge to practical operations and effectively improving their competence in professional positions [2].

2. Current situation of vocational education in medical laboratory technology and analysis of needs for information-based teaching

At present, vocational education in medical laboratory technology faces challenges in terms of teaching resources, teaching models, and evaluation systems. Traditional teaching relies on limited physical experimental equipment and printed textbooks. Some high-end precision instruments, due to high costs and significant operational risks, fail to meet students' practical needs. Additionally, the update of teaching resources lags behind the technological iteration of the industry. Classroom teaching is mostly teacher-centered, with students passively receiving knowledge, lacking systematic understanding of complex testing processes and practical opportunities. In terms of evaluation, it still focuses on summative assessments, which cannot fully reflect students' operational skills, professional literacy, or ability to solve practical problems. As medical laboratory technology rapidly develops toward automation and intelligence, the industry has put forward higher requirements for high-quality technical talents. Information-based teaching methods can break through the limitations of time, space, and equipment, providing resources such as virtual simulation operations and dynamic case databases to meet the needs of practical teaching. Through data-driven evaluation, it enables dynamic monitoring of the learning process and accurate feedback on teaching effects [3]. Therefore, promoting the in-depth integration of information-based teaching and vocational education in medical laboratory technology has become an inevitable choice to improve teaching quality and cultivate talents who meet industry needs.

3. Integrated practice of information-based teaching methods in vocational education of medical laboratory technology

3.1. Information-based construction of teaching resources

3.1.1. Development of virtual simulation experiment platforms

Medical laboratory technology involves a large number of precision instrument operations and complex experimental procedures. Traditional laboratories are restricted by factors such as the quantity of equipment, sample safety, and operational risks, making it difficult to meet students' needs for sufficient practice. The development of virtual simulation experiment platforms aims to restore real clinical testing scenarios as the core goal. Using technologies such as 3D modeling, virtual reality (VR), and augmented reality (AR), they construct virtual experimental environments covering the entire processes of blood analysis, microbial culture, molecular diagnosis, etc. These platforms have functions such as operation simulation, error prompts, and data generation. Students can repeatedly practice operations like hematology analyzer calibration and nucleic acid extraction, and purification in the virtual environment. The system records operational steps in real-time and provides scoring feedback to help students correct errors promptly [4]. At the same time, the platforms integrate typical clinical cases and set up scenario modules such as handling sudden faults and analyzing abnormal results to cultivate students' clinical thinking and emergency response capabilities. For example, in microbial identification experiments, students can observe the morphology of different pathogenic bacteria through virtual microscopes and make comprehensive judgments based on biochemical reaction results, achieving a seamless connection from theory to practice and effectively compensating for the practical shortcomings of traditional teaching.

3.1.2. Production and application of micro-lecture and MOOC resources

The knowledge system of medical laboratory technology courses is complex, covering basic theories, instrument operations, clinical applications, and other aspects. Traditional classrooms struggle to achieve in-depth explanations within a limited time. The production of micro-lecture and MOOC resources focuses on fragmented learning needs, breaking down complex knowledge points into 5–15-minute short videos. For example, for abstract contents such as “the working principle of flow cytometers” and “steps of immunofluorescence staining”, animation demonstrations, live-action shooting combined with teachers’ explanations are used to intuitively present operational processes and core points; for clinical application knowledge such as “quality control of test results,” real cases are introduced for analysis to enhance the practicality of knowledge [5]. In terms of application, MOOC platforms can integrate serialized courses. Students complete a theoretical preview through online autonomous learning, and class time is used for practical operations and answering difficult questions, realizing the “flipped classroom” teaching model. Meanwhile, the platforms support learning progress tracking, online testing, and interactive Q&A, allowing teachers to optimize teaching content based on student feedback. Micro-lecture resources can also be used as after-class review materials, facilitating students to make up for weaknesses, effectively breaking through time and space constraints, and meeting the personalized needs of different learning rhythms.

3.2. Innovation in teaching modes

Traditional teaching of medical laboratory technology is dominated by teachers’ lectures, where students passively receive knowledge and have limited opportunities for practical operations, making it difficult to develop core job competencies. Against the backdrop of informatization, innovations in teaching modes are centered around the “student-oriented” approach, deeply integrating online and offline teaching links.

Through micro-lectures and MOOC resources, students can conduct pre-learning of theoretical knowledge, using fragmented time to independently complete the preview of basic content. This transforms the classroom into a venue for practical operations and problem discussions [6]. Teachers utilize virtual simulation experiment platforms to guide students in simulating clinical testing scenarios, enhancing their comprehensive application abilities through tasks such as real case analysis and instrument troubleshooting. In addition, blended teaching and project-based learning can be introduced into the teaching process. Teachers design comprehensive learning projects based on industry needs, such as “Full Process of Clinical Microbial Specimen Testing” and “Formulation of Quality Control Plans for Routine Blood Tests”. Students, working in teams, complete these projects by accessing digital teaching material databases, conducting virtual experiments, and analyzing real data.

Meanwhile, relying on the real-time interaction functions of online teaching platforms, a multi-dimensional communication space is built between teachers and students, as well as among students themselves. This allows for the timely resolution of learning doubts, stimulates students’ initiative in learning, and effectively improves teaching effectiveness and talent training quality [7].

3.3. Design of information-based process evaluation indicators

Vocational education in medical laboratory technology emphasizes the cultivation of operational standardization, data analysis capabilities, and clinical thinking. The traditional evaluation method based on examinations is difficult to cover the entire learning process. The design of information-based process evaluation indicators is oriented to the needs of professional positions and constructs a multi-dimensional evaluation system. In terms of theoretical learning, the depth and breadth of knowledge mastery are measured by recording students' learning duration of micro-courses and MOOCs, the accuracy rate of answering questions, and the participation in interactions through online platforms. In the practical operation section, relying on the virtual simulation experiment platform, data such as the completeness of operation steps, the accuracy of instrument parameter settings, and the timeliness of handling abnormal situations are collected to quantify practical operation capabilities [8]. The cultivation of clinical thinking is evaluated through dimensions such as the quality of completing case analysis tasks and the innovation of viewpoints in group discussions. Throughout the process, information-based tools are used to realize real-time collection and dynamic analysis of evaluation data, comprehensively reflecting students' growth trajectories in the learning process, and providing a basis for precise teaching and personalized guidance [9].

4. Analysis of the effectiveness of information-based teaching practice

4.1. Evaluation of students' learning effects

In vocational education for medical laboratory technology, a diversified approach is adopted to evaluate students' learning effects, comprehensively assessing their mastery of theoretical knowledge and practical application abilities.

Theoretical assessments are conducted through information-based platforms. By incorporating functions such as time-limited answering and random question selection, these assessments test students' understanding and memory of basic knowledge, including testing principles and quality control standards. The analysis of answer data helps identify weak points in their knowledge acquisition [10]. Practical skill assessments combine the use of virtual simulation experiment platforms with operational evaluations in physical laboratories. Indicators such as the standardization of instrument operation, proficiency in sample processing, and accuracy of experimental results are observed. For example, in the operational assessment of blood cell counting, the operational steps and result error rates between the virtual environment and real experiments are compared [11]. Clinical thinking abilities are tested through case analysis, group project presentations, and other forms. Students are required to design testing plans, interpret results, and write reports based on real or simulated cases, with scores given jointly by teachers and industry experts [12].

4.2. Feedback from teachers on teaching

In the practice of information-based teaching, teachers generally report that the teaching process has undergone significant changes compared with the traditional model. By placing theoretical learning in advance through resources such as micro-lectures and MOOCs, class time can be efficiently used for practical guidance and answering questions, which has significantly improved students' participation in practical sessions and optimized teaching efficiency [13]. However, some teachers also point out that in the early stage of the development of virtual simulation experiment platforms, due to slight differences between the experimental scenarios and real clinical situations, additional efforts are needed to guide students in adjusting from virtual operations to the use of physical instruments [14]. In terms of the application of teaching resources, teachers recognize the auxiliary role of digital teaching material libraries in lesson preparation, which enables them to quickly obtain the latest industry standards and cases. Nevertheless, they also reflect that the update speed of resources sometimes fails to keep up with the iteration frequency of medical laboratory technology. At the same time, the information-based reform of the teaching evaluation system allows teachers to accurately identify students' weak links through data analysis, but it puts forward higher requirements for teachers' ability to interpret data and adjust teaching strategies [15].

5. Conclusion

Practice has shown that the in-depth integration of information-based teaching methods with vocational education in medical laboratory technology has effectively addressed issues such as the scarcity of traditional teaching resources and limitations in practical scenarios, while significantly enhancing students' operational skills and clinical thinking abilities. However, problems like inconsistent standards for resource development and uneven levels of information literacy among teachers and students still restrict teaching effectiveness. In the future, it is necessary to continuously deepen the co-construction and sharing of resources, strengthen the capacity-building of teachers and students, improve teaching management mechanisms, and promote information-based teaching from "superficial integration" to "in-depth empowerment", thereby injecting sustained impetus into the high-quality development of vocational education in medical laboratory technology.

Disclosure statement

The author declares no conflict of interest.

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