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The Application of the NOWLAB System in Sedimentary Petrology Experimental Teaching

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Abstract
The latest NOWLAB system for teaching sedimentary petrology represents a cutting-edge educational approach. By combining microscopy with advanced information technology, it enables innovative, interactive, and tailored experimental learning experiences. This integration advances the modernization of experimental education and establishes a smart, efficient classroom environment. As a result, the system successfully engages students' interest in learning and improves the quality of both practical and theoretical instruction.

KEYWORDS: NOWLAB system, sedimentary petrology experimental teaching, teaching quality

Introduction

Sedimentary petrology serves as a crucial foundational course in geology, primarily focusing on the practical identification of rock thin sections [1-2] . This hands-on course requires students to utilize microscopes to examine various characteristics of rocks, such as composition, sorting, roundness, support types, cementation types, and other microstructures. Students are tasked with describing, classifying, identifying, naming, analyzing diagenetic changes, and exploring the origins of these rocks based on their observations. This process not only reinforces their theoretical knowledge but also helps them develop a three-dimensional understanding of rock microstructures, enabling them to interpret geological information more effectively. These experiments involve students confirming the properties, phenomena, and characteristics of rocks through microscopy [3] .

However, with the rapid advancement of modern educational technology, relying solely on microscopes for experimental teaching is no longer sufficient to meet the evolving needs of the discipline and talent development. To boost students' interest in learning and facilitate a more intuitive observation of the morphological structures and optical characteristics of various rock-forming minerals at the microscopic level—such as distinguishing cleavage and extinction features, colors, and interference colors—the examination of different sandstones under a microscope has become increasingly important [4] . The implementation of the Novel Optics Wireless Lab (NOWLAB) system is crucial for enhancing the quality of experimental course instruction, modernizing teaching methods, quickly gauging students' engagement, and improving overall teaching effectiveness [5] .

1. Current Situation of Sedimentary Petrology Experimental Teaching

Sedimentary petrology experiments encompass a wealth of content, but the teaching approach is primarily descriptive, leading to a somewhat uniform teaching model[6]. Most educational institutions currently utilize a method where instructors provide brief introductions to the microscopic characteristics of rock thin sections, often relying on multimedia images to convey key information. This approach fails to consider students' ability to absorb information, resulting in a lack of clarity in their understanding of what they observe under the microscope, making it difficult to interpret results[7].

Typically, sedimentary petrology laboratory courses serve as a supplement to theoretical classes, and the time allocated for labs is limited. Furthermore, the disproportionate teacher-student ratio places considerable pressure on instructors, hindering their ability to offer thorough and systematic guidance during student observations and to evaluate students' comprehension of the material. For students, outdated lab equipment and uninspiring teaching content do not fulfill their learning needs or spark their interest, causing lab sessions to become mere formalities that do not meet educational goals. As a result, the effectiveness of sedimentary petrology experiments is low, with students only grasping some theoretical concepts and their understanding of sedimentary rocks remaining limited to the images and text found in textbooks, lacking a comprehensive grasp of both macroscopic and microscopic identification features.

As educational reform progresses, the longstanding issue of insufficient teacher guidance in experimental teaching has been effectively addressed, leading to a shift towards a student-centered experimental teaching model designed to cultivate "applied" talents. To support this transition, the NOWLAB digital microscope interactive system has been implemented, creating a digital interactive microscope laboratory, which has become a key objective for laboratory development in the modern era.

2. Digital Interactive Microscope Laboratory Configuration

The digital interactive microscope lab is designed for one teacher and includes one microscope and one computer. It can accommodate up to 40 students, with each student provided with their own microscope and tablet. Additionally, the lab features a projector.

The teacher's microscope is the NP-800TRF, which boasts a wireless long-range optical system and an ultra-large field of view with a high eyepoint flat-field eyepiece EW10X, offering a field diameter of 22mm. It includes a five-hole converter and objective lenses with magnifications of 5X, 10X, 20X, 50X, and 100X. The illumination system consists of a 24V 100W halogen lamp with adjustable brightness. The microscope also has a 1-inch, 20 million pixel C-type interface that allows for photo capture, single frame and sequence recording, dynamic imaging, as well as measurement and annotation capabilities, with a calibration scale of 0.01mm.

Student Microscope: BM2100POL infinite distance optical imaging system; Binocular microscope featuring high eyepoint flat-field eyepiece WF10X with a field diameter of 20mm; includes cross reticle eyepiece, crossline reticle eyepiece, grid plate, and a built-in 5-megapixel camera. It has infinite distance stress-free flat-field achromatic objectives of 4X/0.10, 10X/0.25, 20X/0.40, 40X/0.65, and 60X/0.80, along with an inward four-hole converter and center adjustable feature.

Student Tablet: 10.1-inch IPS LCD screen with a resolution of 1920×1200, featuring a 5-point P+G capacitive touchscreen, running on Windows 10, with 4GB of RAM and a 64GB solid-state drive. It supports WIFI and Bluetooth, and comes with a tablet stand that allows for adjustable angles.

Projector: Utilizes 3LCD projection technology; features a 0.63-inch display chip; brightness of 4000 lumens; contrast ratio of 2000:1; standard resolution of XGA (1024×768), and can synchronize switching with a computer.

3. The functions and advantages of the NOWLAB system.

3.1Teaching management function

Put in place general oversight of the teacher education process. The system features modules for lab report submission, equipment management, classroom engagement, attendance, and performance that greatly increase the effectiveness of instruction. To maintain track of attendance data, teachers can administer their classes, permit student registration, and change and arrange their student lists. Instructors can use their laptops at any time to review and offer advice on the experimental observations made by their pupils. To accomplish unified terminal management, teachers can also launch or stop any student-side applications based on instructional needs. Students can turn in lab reports online and get online grading with interactive teaching tools.

3.2 Classroom teacher-student interaction function

Teachers can use streaming technology to share media files played on their own computers to the student terminals, compensating for the inadequacies of students seated in the back row who were previously unable to see the teacher's screen in full-screen or windowed mode. Additionally, the teacher does not need to walk around the classroom to assess each student's learning situation because they may dynamically adjust each student's class status in real time. This arrangement enhances student comprehension, boosts teacher satisfaction, and saves the instructor time and effort when asking the same topic repeatedly.

The teacher can use voice or text communication to interact with pupils one-on-one or one-to-many during the experiment. In order to provide whole-class training, the teacher can switch screens to address common issues that pupils ran into during the experiment. Without obstructing other students' learning, the system can provide specific instruction to each student regarding their queries. The interactive system can also be used by students to describe unique and common structures seen or mistakes that affect the entire lab [8]. The needs of student tutoring are satisfied and students' excitement for learning is increased through the one-to-many and one-to-one contact formats, turning passive learning into active learning [9].In order to allow students to finish their laboratory classes in a calm setting, this method of instruction has altered the perception of the lab as a "food market."

Classroom quizzes serve as a vital tool for invigorating the classroom environment. Teachers initiate activities during the instructional process and promptly assess the outcomes of their teaching efforts. The teacher inputs questions and answers, establishes a time limit for contemplation and response, prompting students to compete in answering. Upon completion of an answer by the first student, the system automatically evaluates its accuracy. Utilizing a point-based system allows for grouping students to respond collaboratively while fostering competitive engagement with educational content. In organizing classroom discussions, teachers divide students into groups where members can engage in dialogue with one another; additionally, teachers may participate in any group's discussion. The instructor sets several thematic topics for discussion, enabling students to select subjects that pique their interest for more profound exploration.

3.3 Resource sharing function

Traditional experimental teaching methods in sedimentary petrology are limited by the inability to share image resources, as each student can only observe their individual thin section of rock. Even when special or typical structures are identified, other students must wait for their turn to view them by changing seats, which significantly disrupts the flow and discipline of classroom instruction. The implementation of the NOWLAB system allows instructors to seamlessly project images observed through either personal-side or student-side microscopes onto a large screen, thereby facilitating resource sharing and overcoming the constraints of traditional one-on-one observation with microscopes. This enhancement markedly improves students' learning efficiency[10]. Furthermore, for special or typical structures noted during experiments, the system includes a photographic function that enables capturing and saving these images as instructional materials. This model of resource-sharing enriches educational resources and is crucial for enhancing both teachers' pedagogical skills and overall teaching quality.

4. Conclusion and Outlook

This thesis examines the current challenges in the experimental teaching of sedimentary petrology and provides a detailed description of the configuration requirements for a digital interactive microscope laboratory, as well as the functions and advantages of the NOWLAB system. The main conclusions are as follows:

(1) The use of traditional microscope systems in sedimentary petrology laboratory instruction reveals a significant disparity between teaching content, instructional methods, and educational outcomes compared to established teaching objectives. This gap arises from inadequacies in both software and hardware resources, as well as students' varying levels of interest in independent learning.

(2) The development of hardware facilities within the digital interactive microscope laboratory enhances the implementation of the NOWLAB system, allowing for comprehensive utilization of its features and benefits. In contrast to conventional laboratory instruction, teachers can effectively design educational activities, monitor instructional processes, and share teaching resources. Notably, tutoring functionalities during instructional activities and collaborative discussion components play crucial roles in facilitating microscopic observations of sedimentary rocks.

(3) Future applications of the NOWLAB system in sedimentary petrology laboratory education should focus on deeply integrating artificial intelligence technology with curricular frameworks. This necessitates re-designing pedagogical approaches to optimize instructional processes while fostering an efficient smart classroom environment. Such advancements impose higher expectations on both educators and learners: instructors must continuously refine their teaching designs; supported by the NOWLAB system, they should aim to stimulate student engagement, encourage proactive participation, and nurture exploratory spirit alongside creativity—ultimately striving towards enhanced learning outcomes aligned with course objectives.

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