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Research on the Progress and Improvement Path of the Environmental Geology Profession in the Reform of Universities

Yi Qiang, Ronggao Qin, Xiaoling Zhang, Mantao Li*
Kunming University of science and technology, Kunming, 650000, Yunnan, China
*Corresponding Author.

Abstract:

In China's Tertiary institutions, professional reforms are being implemented, and environmental geology majors should focus on cultivating students' professionalism and experimental knowledge. Based on the current context of professional reform in Tertiary institutions, this study explores the current development of the environmental geology profession in the work of universities, the problems it faces and the methods it should adopt to cope with them. It is intended to show the future direction of the work of environmental geology in Tertiary institutions and make some suggestions and recommendations. A keyword search was conducted using Web of Science and Google Scholar with CNKI to include selected literature in the field, and bias analysis was conducted to reduce the risk of bias, while the included literature was collated, analyzed and integrated to explore the current problems in the field of environmental geology in universities and to propose solutions. After searching three databases, 108 studies were included in this study, and 7 of them were excluded according to the selection criteria, resulting in the inclusion of 101 studies. The literature was collated and analyzed to find the current dilemmas and propose solutions to the work related to the environmental geology profession.

Keywords*: Environmental geology, Environmental engineering, Environmental laboratory, Environmental science.*

I. INTRODUCTION

For the teaching of environmental geology majors, the cognition of environmental, geological hazards, the concentration of atmospheric particulate matter and the evaluation of its air quality, the experiment of water quality purification of micro-polluted water sources, the process investigation of wet landing treatment of sewage and the experiment of water quality evaluation as well as the comprehensive investigation and evaluation work and experimental teaching of the urban soil environment and surface sediments are important ways to improve the students' ability and quality. At present, about the reform of the experimental teaching system has been carried out some research [1-2]. However, the role of experimental teaching in cultivating students' ability and quality is still limited. The teaching of environmental geology is organized around the prevention, occurrence, management and evaluation of environmental problems. Laboratory teaching is an inseparable part of the environmental geology system

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and a meaningful way to improve students' practical ability and comprehensive quality. However, the experimental teaching of environmental geology majors lacks a corresponding system planning, which makes the experimental teaching content relatively one-sided and fragmented, and it is not easy to form a compelling whole.

II. METHODS.

The literature search for this paper was conducted using Web of science with Google Scholar and CNKI to 7 April 2022 with the following search terms: 'laboratory teaching' or environmental geology or 'environmental, geological engineering'. Includes surveys, reports, and guidelines. Papers are available in English and Chinese.

The articles were initially screened by title and abstract. The review of titles or abstracts against inclusion criteria in the full-text review and the assessment of the risk of bias and study quality against Cochrane guidelines included possible biases such as selection bias and selection bias in the review, with three members of this group dedicated to the assessment of bias and ultimately consensus within the group.

III. RESULTS

After a search exercise in three databases, a total of 108 studies were included in this study, of which seven were excluded based on the selection criteria, resulting in the inclusion of 101 studies, most of which presented dilemmas faced in the teaching of experiments in environmental geology and offered relevant advice to address these problems, with two articles written by different members of the same unit or subject group with similar findings. The process of literature inclusion is illustrated in Fig 1 Some of the included articles had not been peer-reviewed. This raises the difficulty of this study. The analysis led us to conclude the following points.

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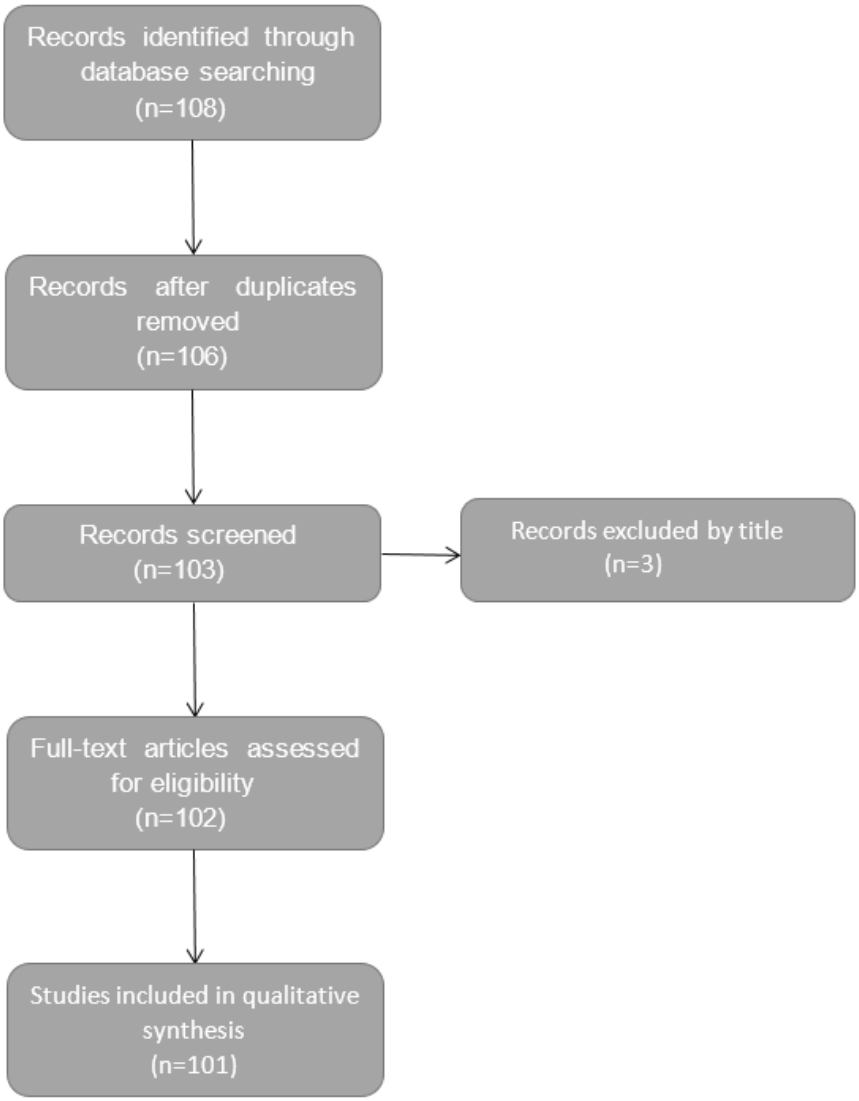

Fig 1: Data filtering process

3.1 The Dilemma Facing Experimental Teaching in Environmental Geology

3.1.1 Late awareness of the concept of experimental teaching

Experimental teaching has long been considered dependent on theoretical teaching, which is the verification and supplement of theoretical teaching. The purpose is to "consolidate and deepen the effect of classroom theory teaching"; overemphasis on the guiding nature of theory, ignoring the role of experiments to complement, deepen and develop theory, resulting in the status of experimental teaching being far below theoretical teaching, limiting The development of experimental teaching is limited [3]. This lagging concept makes it difficult to coordinate the two closely related and independent links between experimental and theoretical teaching, which is not conducive to cultivating students' innovative spirit and creative, practical ability.

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3.1.2 Inadequate experimental teaching system

The curriculum of environmental geology is relatively weak in terms of curriculum relevance due to the wide range of knowledge required by profession, resulting in what is commonly referred to as "miscellaneous". As traditional laboratory teaching is considered to be the verification of theoretical courses and a supplement to theoretical learning, the "miscellaneous" character of the laboratory teaching is more prominent. The traditional plan of the course, the responsibility of the teachers and the configuration of the experimental conditions become the basis of the practical courses, but whether these experiments need to be offered, whether the experiments offered need to be updated and whether the experiments achieve the purpose of improving students' ability are less considered, resulting in the experimental teaching only becoming a numerical indicator to meet the demand of practical teaching credits in the training plan. Through the research on experimental teaching in some universities in China, we found that establishing an experimental teaching system is an issue worthy of attention [4]. How to reasonably reflect the requirements for the practical ability of majors in the training program and establish a sound experimental teaching system are the basis of the current experimental teaching reform and the establishment of separate experimental courses.

3.1.3 Obsolete experimental content, methods and organization

Due to the existing management system, teachers are not highly motivated to open new experiments, and the content of experimental teaching is mainly based on the traditional experiments inherited from the university, making the starting point of the course lower, the teaching content old, narrow in scope, and the articulation and coordination between experimental projects insufficient [5]. At the same time, there is a particular gap between the content of the experiments and the natural environmental problems, which does not highlight the complexity and comprehensive characteristics of environmental problems, and does not reflect the latest knowledge, the latest developments and the latest experimental methods of the discipline. In terms of teaching methods and organization, basic experiments such as verification and demonstration are still the main ones. There is a lack of understanding of the purpose of fundamental experiments and the problems to be solved, resulting in the content and methods being relatively old.

3.1.4 Not very effective in teaching

Due to the problems of the experimental course itself and the experimental assessment is not scientific, not strict, neither "pressure" nor "motivation" for students, resulting in students' lack of attention to the experimental course, the teaching effect is not significant. From the independent experiments of graduation design (thesis) students and the investigation and assessment of experiments in the annual postgraduate retest, we can feel that there is a significant shortage of experimental teaching in terms of quality and ability cultivation.

3.2 Reconstruction of the Experimental Teaching System of Environmental Geology Majors in the Context of Higher Education Reform

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Experimental teaching in higher education is a bridge between theory and practice and is a crucial way to train students to change from knowledge to ability; experimental teaching and theoretical teaching are two independent and unified links, so they should be the same as theoretical teaching, and experimental teaching should also have its own relatively independent system [6]. In this educational reform work, the reconstruction of the professional experimental teaching system is undoubtedly the most important.

3.2.1 Problems that need to be addressed in the experimental teaching system

The ultimate purpose of experimental teaching is to cultivate students' innovative consciousness and problem-solving ability [7], so the experimental teaching system needs to solve the systematic and structural problems related to experimental teaching in professional construction. Through a comprehensive analysis of the courses, teaching plans, syllabuses, teaching materials, teaching methods and means systems, as well as the assessment and evaluation systems of experimental teaching, the core elements of courses, contents and methods are formed, the objectives of different experimental levels are clarified, the top-level design and overall structure of experimental teaching are completed, the experimental teaching tasks of undergraduate courses are effectively organized and implemented, and the effectiveness and quality of experimental teaching are improved, It is conducive to the cultivation of students' practical ability and innovation consciousness [8].

3.2.2 Principles for the construction of the experimental teaching system

To update the educational thinking and concept, to cultivate students' practical and innovative ability as the core, to improve students' hands-on ability and comprehensive analysis and problem-solving ability, to set up experimental projects according to the relevant requirements of the Steering Committee of Professional Teaching and Curriculum Teaching of the Ministry of Education, and to set up experimental projects based on the objectives of personnel training and the overall needs of professional teaching. The whole experimental teaching system is systematized, hierarchical and open, which improves the quality of experimental teaching and enhances the cultivation of students' practical and innovative abilities.

The following principles should be followed in the design of the experimental teaching system:

(1) Articulation with the prerequisite courses

Pre-courses related to environmental and geohazard assessment include Introduction to Earthquakes, General Chemistry, General Geology, Physical Chemistry, Petrology, Tectonic Geology, Fundamentals of Hydrogeology, Hydrogeochemistry, Environmental Hydrochemistry, Groundwater Dynamics, and Water Environment Monitoring and Assessment.

It is recommended that the knowledge applied to the evaluation of environmental and geological hazards, such as primary hydrogeological problems and water quality assessment, be taught in general

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chemistry, physical chemistry and hydrogeochemistry courses and be reflected in practical lessons.

Introduction to Seismology, General Geology, Tectonic Geology and Petrology, as introductory courses in geology, provide an excellent geological foundation for groundwater courses and engineering students. For example, the geological role of surface water and groundwater, the development of tectonic fissures, the formation and characteristics of the three major rock types are the primary conditions for the formation of groundwater chemistry and lay the foundation for the evaluation of the environmental impact of groundwater and the evaluation of geological hazards.

Of these courses, the first three are introductory courses in hydrogeology, hydrogeochemistry, groundwater dynamics and water environment monitoring and assessment. At the same time, the latter is an elective course that is most closely related to the teaching of environmental and geological hazards assessment. For example, water quality analysis of samples, including simple analysis, complete analysis and precise analysis of three kinds. Simple analyses are carried out in the field, with few items, but are quick and timely and are suitable for a preliminary understanding of the leading chemical composition of groundwater in aquifers over a large area. Technical analyses are carried out according to the needs of the specific task, such as water chemistry, using a high-precision spectrometer to analyze some of the metal ions being searched for, or water radioactivity, focusing on certain radioactive elements. This is where teachers need to pay particular attention to the unification of concepts in the classroom. To evaluate the groundwater environment of an area, the first step is to develop a conceptual model of hydrogeology, which is what is studied in groundwater dynamics. For example, it is necessary to determine whether the aquifer is a submerged aquifer or a pressurized aquifer and to determine the nature of the aquifer, including whether it is homogeneous, isotropic or anisotropic, how it varies in thickness, how large it is, whether it can be considered to be infinitely extended, and to identify the conditions of recharge, runoff and discharge, all of which require a prior knowledge base.

(2) Content systematization.

Following the law of student cognition and the law of teaching, according to the professional training objectives and the teaching requirements of the practical courses, the experimental content is progressive according to the basic, design and comprehensive, reflecting the integrity and logic of the knowledge system as far as possible.

(3) Effective integration with concurrent courses

The courses offered simultaneously include Principles and Prevention of Groundwater Pollution and Hydrogeology, which focus on the sources and routes of groundwater pollution, as well as the hazards of groundwater pollution and its prevention. There are some intersections with the teaching of environmental and geohazard assessment, such as the sources of groundwater pollution and pollution pathways. At the same time, in the classroom teaching of environmental and geohazard assessment, teachers should cut down the repetitive knowledge points to improve the quality of classroom teaching.

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(4) Openness to teaching.

In addition to the course experiments, open experiments are set up. According to the open nature of the experiments, they are divided into fixed open experiments and extended open experiments.

(5) Proficiency in the use of software in environmental and geohazard assessment

As the content of environmental and geohazard assessment focuses on integrating theory and practice, teachers should require students to master the basic principles and operation of environmental and geohazard assessment-related skills and simulation software so that students can use the simulation results of this software to solve practical problems.

Environmental and geohazard assessment experiments should be strengthened, especially the teaching and use of assessment simulation software. GMS software can be used for geological modelling and groundwater environmental impact prediction. GMS software can be used for geological modelling and groundwater environmental impact prediction and analysis. The use of modules such as MODFLOW and MT3DMS to predict groundwater quantity and quality can improve efficiency. GIS technology can be used to analyze geological hazards' hazard and risk zones, which is good technical support for students to research an environmental and geological hazard assessment. Therefore, within the limits of the class time (i.e. the prescribed number of hours), some of the software functions can be screened for fundamental principles and examples, and the students are allowed to operate and discuss the application of the software in class. Because class time is limited, students are grouped in practical sessions designed according to the requirements of the course, and the results are reported.

(6) Increase the design of the course, mobilize students' learning initiative and explore open teaching

The course should be based on the basic theory of environmental and geohazard assessment, and the fundamental task is to be able to integrate the actual environmental problems and design the course based on the research hotspots in groundwater science and engineering. Students prepare an environmental impact report per national regulations and technical specifications. This combination of theory and practice enhances students' interests and provides a good foundation for their future work. This combination of theory and practice provides a platform for students to combine practice and theory in their professional studies, fostering a creative spirit of exploration and enhancing their practical problem-solving skills.

3.2.3 Reorganization and construction of experimental teaching system for environmental geology majors

The module-based experimental teaching mode is the primary method currently used. There are different ways of dividing the modules used, such as "verification experiments", "comprehensive experiments", "design experiments". The modules are divided in different ways, such as "verification experiments", "comprehensive experiments", and "design experiments". Others are divided into "basic

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experiments", "specialized experiments", and "comprehensive experiments", as well as "basic skills training experiments Some are classified as "basic experiments", "specialized experiments" and "comprehensive experiments", as well as "basic skills training experiments", "theoretical course verification experiments", "comprehensive design experiments" and "exploratory and application experiments". This classification only highlights a particular aspect of the content, with less connection between the modules and the requirements of the training objectives. On this basis, we analyzed the relationship between each module and formed a framework for the experimental teaching system of environmental geology. In this experimental teaching system, we divide it into three levels of competence training and specify the tasks and objectives of each level of training and the main experimental courses offered at the corresponding level and the relationship between them.

For the fundamental experiments, in line with the principle of few but precise, mainly for the essential practical skills training, the development of good experimental operation and experimental report writing norms. The main focus is on constructing professional application experiments with unique features, and the process mainly highlights the comprehensive professional experiments related to practical problems. At the level of innovative ability cultivation, the primary purpose is to extend the classroom aspect of experimental teaching to the extra-curricular aspect so that students can receive quasi-frontier scientific research training and lay the foundation for future students to engage in scientific research in the field of environmental geology.

IV. DISCUSSION

Through summary and collation, in the context of education reform, this study summarises the previous foundation to develop some more comprehensive professional basic and professional application experiments, through these experiments to strengthen students' understanding of professional knowledge and gradually connected with the actual environmental problems, and achieved good results. The main experiments are:

(1) Monitoring and evaluation of environmental and geological disasters. With the continuous development of human society and the application of high-tech achievements, the use and development of mineral resources by human beings have become more extensive, leading to the emergence of environmental and geological problems that continue to deteriorate. This has put forward new requirements for teachers and students of groundwater science and engineering: teachers should keep up with the times, constantly increase their professionalism, keep pace with the times, solve the problems of the entire society, and then teach students the ability to solve such problems.

(2) Monitoring and evaluation of water samples from different geographical areas. Based on the surrounding geological and environmental conditions, students collect water samples from surface water, urban landscape water, tap water, groundwater, urban sewage and other water samples, determine the analysis indexes and corresponding analysis methods for different water samples, and evaluate the water quality of the water samples through analysis. This laboratory enables students to understand the purpose

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of monitoring different water samples, the analysis methods and the differences between them, and to learn the individual and comprehensive evaluation of water quality.

(4) Water purification experiments of micro-contaminated groundwater. Organic micro-contaminated groundwater samples were collected, degraded using photocatalytic methods, and then purified using membrane separation techniques. The relevant evaluation indicators are shown in TABLE I. This experiment provides students with an in-depth understanding of the methods and techniques used to control water quality.

TABLE I. National requirements for water pollution indicators

Indicators	National Standards（2014） w_j	National Standards（2016） w_j	National Standards（2019） w_j
Potassium permanganate index	0.18	0.19	0.2
Ammonia nitrogen	0.16	0.15	0.18
Total Nitrogen	0.23	0.27	0.22
Total phosphorus	0.29	0.27	0.27
Chemical oxygen demand (COD)	0.13	0.12	0.14

(5) Comprehensive investigation and evaluation of the soil environment and surface sediments. Soils and surface sediments from different areas were collected and analyzed for particle size composition and the content of primary heavy metals and evaluated.

In order to ensure the smooth implementation of the experimental teaching system, this working group focused on the following areas:

(1) Continuous reform and innovation. According to the requirements of environmental geology majors in the field of knowledge and ability, we take the formulation of a complete experimental syllabus and experimental teaching materials as the starting point and strengthen the innovative elements and innovative connotation design of experimental teaching contents. The objectives of different levels of experiments are clearly defined, with the basic experiments being fewer and more precise, highlighting the basic training, and the professional application experiments being the core and focus of the teaching system, highlighting their comprehensiveness and realizing the link between the teaching process and the solution of practical scientific problems. The innovative level is characterized by research experimental teaching [9], highlighting the research of scientific problems in environmental geology.

(2) Establish a reasonable incentive mechanism. Based on the characteristics of laboratory work, the laboratory should implement a quantitative performance system that integrates teaching, research, and

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social benefits to improve laboratory teachers' motivation [10].

(3) The construction of a high-level experimental teaching team is the key to completing the experimental teaching system. Arrangements are made to improve young teachers' professional theoretical knowledge and scientific research ability through further training in courses and participation in scientific research. According to their professional background, young teachers are arranged to participate in scientific research projects in the corresponding disciplines and research platforms. In this way, we promote the construction of a high-level faculty team.

V. CONCLUSION

Carrying out the reform of the experimental teaching system of environmental geology is of great significance to the continued implementation of the educational reform in universities. Previously, through the continuous efforts of our educators, the quality of experimental teaching in environmental geology in China has been continuously improved. This has strongly promoted the professional construction work of our universities. Under the current new situation, we should take the experimental teaching of environmental geology as the starting point and breakthrough point of teaching reform and continuously build and improve the implementation of education and teaching work in our universities.

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