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*Original Paper*

# Practice on the Construction of "Engineering Geology" Smart Course from the Perspective of Digital Intelligence Empowerment

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***Abstract***

*The digital transformation of education is an important direction for the reform and development of higher education at present. Under the background of the era of digital intelligence empowerment, this paper sorts out the knowledge system characteristics and teaching practice dilemmas of the "Engineering Geology" course, combines the concepts and progress of smart classroom construction, and explores the path of the "Engineering Geology" course construction from aspects such as curriculum resource construction, teaching mode reconstruction, and innovation of practice links. The curriculum construction mode with knowledge graph construction, AI-assisted teaching, and virtual simulation experiments as the core helps to solve problems such as the disconnection between theory and practice and low student participation in traditional teaching, and provides practical reference for improving the quality of engineering geology talent cultivation.*

***Keywords***

*Engineering Geology, AI, smart classroom, course construction*

## 1. Research Background

The report of the 20th National Congress of the Communist Party of China clearly put forward "promote digital education and build a learning society and a learning power for lifelong learning for all". The General Office of the Ministry of Education clearly put forward to promote the action of "empowering the improvement of teaching quality with digital technology" and build a new teaching and learning mode under the digital background. Under the background of digital education, the higher education field is undergoing a transformation from informatization to intelligence, and digital technology has become an important force to reshape teaching content, methods and forms.

As a core basic course for civil engineering majors, the “Engineering Geology” course undertakes the important task of cultivating students’ comprehensive ability to identify, analyze and solve geological problems in engineering activities. The course focuses on the cultivation of engineering geological exploration, disaster prevention and control, and engineering site selection capabilities, and has the characteristics of high theoretical abstraction, strong interdisciplinary nature, and excellent practical intelligence. How to empower curriculum construction with digital intelligence technology, break through the time and space limitations of traditional teaching, and improve teaching quality has become an urgent topic to be explored. On the basis of sorting out the course characteristics and teaching status, combined with the changing trend of digital intelligence empowerment, this paper explores the basic framework and practical path of curriculum construction, hoping to provide reference for the reform of geological courses under the background of new engineering.

## 2. Construction of Engineering Geology Course Resources Empowered by Digital Intelligence

### *2.1 Existing Digital Platforms and Resource Bases*

The National Higher Education Smart Education Platform integrates course platforms such as China University MOOC, Superstar Learning Pass, and Wisdom Tree, includes course resources of more than a thousand universities, and provides virtual simulation experiment courses in multiple professional categories, providing basic conditions for the digital transformation of the “Engineering Geology” course.

The high-quality curriculum resources in national universities are rich, and among them, the MOOC courses related to engineering geology cover a complete system from basic theory to application practice. For example, the virtual simulation experimental teaching platform provides a batch of virtual simulation course resources such as virtual simulation experiments for mineral identification and virtual simulation experiments for tunnel construction methods. These resources help to a certain extent to break through the dependence on sites, equipment and specimens in traditional experiments and provide a more flexible learning method for students. Another example is that the rock and ore fossil specimen resource sharing platform integrates the rock and ore specimen resources of universities and research institutes and provides material support for the online identification teaching of minerals and rocks. In teaching, this platform can be combined with the on-campus rock and ore specimen laboratory to help students understand and master the optical and mechanical properties of minerals and the mechanical characteristics of rocks from a sensory perspective.

### *2.2 Application Potential of Virtual Simulation and Intelligent Tools*

The development of virtual simulation teaching resources has also been increasingly emphasized. By building various virtual simulation libraries to restore geological disaster scenarios, students can use geographic information system tools to carry out simulation analysis and verify the effects of different solutions through virtual simulation experiments. The introduction of numerical simulation software and artificial intelligence tools provides new technical means for engineering geology teaching.

Professional software can be used in teaching links such as slope stability analysis and tunnel surrounding rock stability evaluation. By establishing a geological model, setting boundary conditions and analyzing calculation results, students can more intuitively understand the deformation and failure process of rock and soil masses under engineering effects. In teaching, computer vision and deep learning technologies can be introduced to let students understand how to use algorithms to identify rock mass fractures and structural plane characteristics. Technologies such as intelligent drilling and AI rock identification have also begun to enter the curriculum system, providing opportunities for students to get in touch with data processing and digital technologies.

## 3. Practical Exploration of Engineering Geology Course Construction

### *3.1 Organization of Course Content Based on Knowledge Graph*

In the teaching of engineering geology courses, the construction and application of knowledge graphs are important starting points for digital intelligence empowerment. The course content can be sorted out by knowledge points into levels such as concepts, principles, methods, and cases, and knowledge graphs, ability graphs and problem graphs can be constructed. The teaching implementation can be carried out in three stages: before class, during class and after class.

**Table 1. The Application of Knowledge Graph in Different Classroom Stages**

| Classroom stage | Application points of the knowledge graph |
|---|---|
| Pre-class stage | Students independently learn basic concepts through the platform, and the system pushes learning resources according to learning behavior data. |
| In-class stage | The teacher analyzes the key points and difficulties in the knowledge graph and organizes students to discuss around engineering cases. |
| After-class stage | Students conduct consolidation training through the problem map, and the system generates feedback on the learning situation. |

In practice, it is possible to try to introduce an agent collaboration mechanism and carry out training by simulating engineering scenarios. When analyzing complex engineering problems, students can complete the entire process from data collection to solution design. Relevant teaching practices have shown that this kind of approach helps to improve students’ comprehensive analysis ability.

*3.2 Practical Teaching Design Combining Virtual and Real*

In view of the characteristics of engineering geology practice teaching, virtual simulation experiment projects can be developed, covering typical geological disaster scenarios such as landslides, collapses, and debris flows. Taking the teaching of landslide prevention as an example, students can be guided to integrate the knowledge of hydraulics and geomechanics, analyze the formation mechanism of landslides through virtual simulation experiments, and verify the effects of different reinforcement schemes by model operation.

The practical teaching combining virtual and real can construct a teaching scenario that links the field real scene and virtual simulation. In the teaching of tunnel engineering geology, students can first conduct construction simulation experiments in the virtual environment to understand the construction process and key points of geological risk identification, and then go to the training base for practical training. This virtual-real combination mode helps to solve the problem of difficult practical operation in high-risk scenarios to a certain extent.

*3.3 Case-Driven Intelligent Analysis Teaching*

Intelligent analysis teaching with typical cases as the carrier is an important content of the construction of the engineering geology course. Practical cases help to stimulate students' learning interest and promote in-depth thinking about engineering geology problems.

**Table 2. Practical Case of Intelligent Application**

| Case Name | Intelligent Application Practice |
|---|---|
| Case of Slope Stability Analysis | Based on an actual slope, students collect topographic data, combine on-site information, understand the application of machine learning methods in slope stability prediction, and conduct stability analysis under different working conditions with the help of numerical simulation software to deepen their understanding of slope instability mechanisms and early warning methods. |
| Case of Rock Mass Structure Identification | Taking a rock engineering site as the object, students can understand the application of computer vision technology in rock mass fracture identification and feel the changes brought by technological development by comparing the differences between traditional and intelligent methods. |
| Case of Geological Disaster Simulation | By constructing a disaster scenario with virtual reality technology, students can conduct risk analysis, disaster evolution prediction and response plan formulation on the simulation platform, and complete the process training from disaster identification to emergency response in a virtual environment. |



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## 4. Improvement Ideas for the Teaching Evaluation of Engineering Geology Courses

The course evaluation empowered by digital intelligence can be expanded from summative evaluation to formative evaluation. The evaluation indicators can cover multiple dimensions such as classroom participation, online learning behavior, completion of virtual simulation experiments, group project results, and final exam scores. Based on the student behavior data collected by the learning management system, the learning effect can be analyzed to form a feedback on the learning situation.

Diversified evaluation methods can be adopted, including classroom performance, usual homework, experimental practice, online learning, final exams, etc. into the evaluation scope, aiming to more comprehensively reflect the students' knowledge mastery and practical ability.

## 5. Conclusion

The construction of engineering geology courses under the background of digital intelligence empowerment is a beneficial exploration to adapt to the development trend of higher education and respond to the needs of talent cultivation. Judging from the existing research and practice, the course construction idea centered on knowledge graphs, AI assisted teaching, and virtual simulation helps to address issues such as the disconnection between theory and practice and low student participation in traditional teaching, providing new possibilities for improving teaching effectiveness.

Course construction is a process of continuous exploration, and many aspects can be continuously optimized. In terms of the construction of the teaching staff, ways such as special training and interdisciplinary exchanges can be considered to improve teachers' ability to use digital technology in teaching; in terms of resource sharing, platforms such as virtual teaching and research offices can be relied on to promote the co-construction and sharing of course resources, teaching cases, and virtual simulation experiments, reducing the threshold of course construction; in terms of the integration of production and education, the connection with industry enterprises can be strengthened, and the latest engineering cases and technological developments can be concerned to keep the teaching content moderately connected with actual needs. With the development of artificial intelligence technology and the deepening of educational concepts, there is still broad exploration space for the construction of engineering geology courses.