

Original Paper

Application Analysis of Gamification in the Smart Classroom of Engineering Geology

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Abstract

Against the backdrop of rapid digital development, teachers are confronted with prominent teaching difficulties: students rely excessively on mobile phones, fail to internalize knowledge effectively, lack subjective initiative and intrinsic learning motivation. This teaching innovation aims to arouse students' curiosity, cultivate their engineering thinking and facilitate in-depth knowledge transfer. By integrating knowledge into games, we realize entertaining and effective teaching. To tackle the core problems of current university classrooms, this paper embeds the key knowledge of Engineering Geology into gamified teaching. It explores ways to deliver course content via zero-cost mini-games, which are designed as cross-terminal tools running through pre-class, in-class and after-class learning sessions. Adopting the "case + game" model, a dual-cycle teaching system combining in-class and extracurricular learning is established. Diversified game tasks serve as the criteria for formative assessment to promote the practical development of gamified teaching for geology courses. This paper elaborates on innovative ideas and implementation approaches, and continuously optimizes the scheme based on real teaching feedback to improve teaching quality. The ultimate goal is to cultivate high-quality applied talents with a strong sense of social responsibility, global vision and innovative spirit. By integrating high-quality international educational resources, we strive to provide city-oriented and globalized education as well as public services.

Keywords

Engineering Geology, Gamified Teaching, Smart Classroom

1. Introduction

1.1 Innovation Background

Today's students are generally active in thinking and adept at practical operation, yet they tend to be intimidated by abstract theoretical knowledge. Influenced by exam-oriented education for a long time, they have not developed sound learning habits or confidence in independent exploration. Teachers devote themselves to lecturing on the platform, while few students engage in class. Mobile phones have become a shelter for students to escape from classroom learning. As an educator, I often feel like a lonely performer in an inefficient classroom. The disconnection between teaching and learning not only drains teachers' enthusiasm but also hinders students' future development. I was determined to break this awkward situation and make a change.

Accordingly, my teaching focus has shifted fundamentally from how much I teach to how much students learn and what they can become. More important than individual knowledge points are the abilities of autonomous learning and critical thinking, which equip students to cope with career challenges and achieve lifelong growth. Mobile phones, originally entertainment devices for students, are transformed into powerful learning tools in this practice. The gamified teaching innovation is born out of this original intention, representing an active attempt to break the deadlock of traditional teaching.

With game-based design, the classroom is rebuilt into a shared "game arena" for teachers and students. In this new environment, teachers are no longer mere lecturers, but guides and partners accompanying students on the journey of knowledge exploration. Students, on the other hand, evolve from passive listeners into active knowledge explorers. We can see students taking the initiative to look up materials and hold discussions to complete game challenges, which is exactly the process of cultivating their independent learning ability and critical thinking. This attempt may not completely change students, but it plants a seed in their minds that will take root and sprout in their future study and life.

1.2 Major Problems Addressed by Teaching Innovation

(1) Solve Typical Classroom Problems

It is common to see students bowing down to play with phones in class, seeking answers from AI during quizzes, and playing mobile games instead of participating in group discussions. Mobile phones severely undermine learning enthusiasm. Rather than banning their use, we make full use of mobile devices and guide students to acquire knowledge through mobile mini-games.

(2) Promote Interdisciplinary Integration for Intelligent Construction Major

Aligned with national strategic needs and the transformation and upgrading of the construction industry, the Intelligent Construction major combines Mechanical Design, Manufacturing and Automation, Computer Science and other disciplines, realizing the integration of traditional civil engineering and intelligent technologies. The design of mini-games helps foster students' awareness of interdisciplinary learning and encourages them to carry out cross-major consultation and cooperation.

1.3 Training Objectives

1.3.1 Knowledge Objectives

This is the basic requirement of the course. Students are expected to identify common rocks, analyze basic geological structures and their influences on civil engineering. They also need to understand geological problems in typical projects such as underground caverns, slopes and foundations, and apply theories of engineering geology to civil engineering practices.

1.3.2 Ability and Literacy Objectives

① **Independent Learning Ability — Learning by Playing** Most students lack learning initiative. Games, a well-received form of activity, motivate students to acquire knowledge actively and explore effective learning methods. Matching knowledge points with appropriate game types requires students to sort out and dig into course content, which is a process of autonomous learning. Academic knowledge can be supplemented later, while independent learning ability is far more valuable. As the saying goes, Give a man a fish and you feed him for a day; teach a man to fish and you feed him for a lifetime.

② **Problem-solving Ability — Learning by Doing** Students are encouraged to select proper game types, formulate rules and design mini-games on their own. Writing game scripts and developing games enable students to discover and solve practical problems. Most students are afraid of difficulties and tend to be lazy. Interest can guide them to face and tackle problems, and gradually overcome negative mindsets.

③ **Critical Thinking Ability — Thinking while Learning** During gameplay, students are guided to put forward constructive suggestions to optimize games for better playability and more accurate presentation of professional knowledge. Repeated revision and improvement in game design trigger brainstorming activities. Students are capable of thinking independently, yet they are often reluctant to do so. Teachers should inspire students to think rather than replace their thinking.

2. Research Methods and Implementation Approaches

2.1 Teaching Innovation Method

The core of this innovation is the establishment of a game-based knowledge exploration model. Abstract knowledge points of Engineering Geology (e.g., mineral hardness classification) are converted into themed mini-games with clear objectives and rules, such as Mineral Elimination.

2.2 Implementation Approaches of Teaching Innovation

2.2.1 Build Game-based Learning Paths

Key questions and thinking guidelines are designed for each game. Students first learn relevant knowledge and then take part in games for consolidation. Teachers introduce game production methods and encourage students to turn knowledge points into practical mini-games. By playing games together with students, teachers help identify existing flaws and discuss optimization plans. Students are positioned as the main participants throughout the teaching process.

2.2.2 Implement Multi-dimensional Incentive Mechanisms

Rankings are set according to game scores and playing duration. Excellent student-designed game scripts are collected into the course case library. Students who put forward valuable professional ideas will be awarded the title of “Chief Geological Engineer”. These measures transform students’ learning motivation from the external goal of passing exams into the inner pursuit of game challenges, a sense of achievement and professional identity, thus stimulating sustainable and powerful intrinsic learning drive.

2.3 Main Learning Activities of Students

2.3.1 Course Overview and Class Hour Allocation

The total class hours of the course are 32. Student learning activities are divided into four parts with the following proportion:

- 1) Online learning (13%): Students watch course videos and study materials via the Chaoxing Learning Platform.
- 2) In-class teaching (60%): The main teaching section integrating case teaching, gamified activities, group discussions and knowledge expansion.
- 3) Experimental courses (13%): Focused on practical operation and skill training.
- 4) Advanced group tasks (14%): Students complete high-level learning tasks in groups.

2.3.2 Teaching Implementation and Assessment

- 1) Online learning: Assessment is based on background data from the Chaoxing Platform, including online learning duration and completion of exercises.
- 2) In-class teaching: Teaching starts with typical cases, followed by mini-games and group discussions. Students’ performance in games (such as clearance time) is included in the assessment.
- 3) Experimental courses: Evaluation is conducted based on experimental reports.
- 4) Advanced group tasks: Each group selects suitable game types based on course knowledge, completes the whole process from script design to game production, and delivers presentations for final evaluation.

3. Effects of Teaching Innovation

The application of gamified teaching has achieved remarkable results in three aspects: diversified assessment modes, positive transformation of students’ learning attitudes and substantial improvement of core competencies.

3.1 Assessment: From Static Evaluation to Dynamic Experience

A process-oriented and data-driven assessment system runs through all game activities, which automatically records students’ attempt times and clearance duration for each game. Different from traditional evaluation that only focuses on answer correctness and task completion, this system clearly reflects students’ performance in knowledge learning, knowledge application and resilience. Relevant

cases show that students master knowledge points with game links much better than those without. It proves that gamified teaching effectively promotes knowledge internalization and transfer.

3.2 Student Feedback: From Passive Reception to Active Participation

Students' attitudes towards classes have changed fundamentally. According to student interviews, more than 80% of the respondents believe that chapters with game activities are more attractive and help them concentrate in class. Their comments have shifted from complaining about boring and obscure content to praising the challenging and rewarding classroom experience. One student shared: "I used to play with my phone in class, but now I discuss game plans with my classmates enthusiastically on it. It feels totally different." Mobile phones have changed from learning distractions into useful learning tools, and students have transformed from passive recipients into active participants.

3.3 Student Development: From Knowledge Recipients to Independent Explorers

The most profound achievement lies in the overall improvement of students' learning abilities. Driven by gamified scenarios, students demonstrate stronger independent learning ability and critical thinking. They take the initiative to search for online resources and consult professionals across disciplines to optimize game strategies, and hold in-depth discussions within groups to work out optimal solutions. This innovation successfully turns students from passive knowledge receivers into active explorers and collaborative problem-solvers. The engineering thinking and good learning habits cultivated through active exploration are more precious than specific knowledge points.

4. Universality of Gamified Teaching Practice

The gamified teaching framework enjoys strong universality. Its core logic is to convert simple knowledge transmission into situational problem-solving, which can be applied to different courses and disciplines.

4.1 Application within the Same Course

Teachers can directly adopt this gamified teaching model for students at different levels and majors taking this course. More practical data can be collected to further revise and optimize the teaching system.

4.2 Application within the Discipline

Other core courses of civil engineering, such as Soil Mechanics and Foundation Engineering and Principles of Concrete Structure Design, also emphasize knowledge application and standard implementation. Teachers only need to design new game scenarios and types according to the teaching objectives of each chapter, and the existing teaching procedures and incentive mechanisms can be reused.

4.3 Cross-disciplinary Application

Most engineering courses share similar characteristics. The underlying mechanism consisting of course objectives, game rules, assessment systems and incentive methods is universally applicable. For any

course that requires students to apply, analyze and make decisions, this model can be adopted by adjusting game rules and learning content. It can effectively stimulate students' learning motivation and improve their comprehensive literacy.

5. Challenges in Innovation Practice

5.1 Major Challenges

1) The team faces a prominent contradiction: we aim to build a comprehensive gamified classroom, but suffer from two realistic constraints no prior game design experience and limited funding. Therefore, we cannot adopt technology-intensive solutions and have to explore practical, efficient and iterable approaches.

2) It is difficult to convert abstract engineering geology knowledge into interesting and educational games. Since the teaching team has no background in game development, complex game engines and programming languages are not feasible. All solutions must be based on zero cost and low technical barriers.

5.2 Solutions

1) Simplify design and leverage AI tools

We abandon the idea of developing large and complex games, and focus on designing micro-games. Each core knowledge point (such as distinguishing the age of strata and identifying slope failure modes) is designed into simple classic game forms: Q&A challenges, sorting games, picture matching and drag-and-drop classification. Mature AI tools are fully utilized: AI generates game codes based on designed logic, and free platforms convert codes into interactive links. Students can enter the game interface simply by opening the links on mobile phones.

2) Prioritize teaching design over game production

Simple technical design can be compensated by elaborate teaching design. We focus on defining learning objectives and cognitive progression for each game level. Every operation in the games corresponds to a knowledge point that students need to understand and apply. The fun of games lies in the sense of accomplishment brought by solving puzzles and applying knowledge, rather than gorgeous visual effects.

Teaching innovation in the digital era is essentially an education reform oriented to students' future development. Teachers should act as a bridge connecting students' inner potential and interests with the trends of social development. Ultimately, we need to guide students to grow into talents who can not only adapt to changes but also lead future development.