

# Exploring Diversified Classroom Teaching Modes for Graduate Forest Fire Management Courses

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**Abstract.** Forest fire management is an important pillar of China's forestry development, and talent cultivation in this field needs to be further strengthened. Diversified classroom teaching modes are proposed for different forest fire management courses, including a single-subject teaching mode with a focus on either students or teachers, and a dual-subject teaching mode with a focus on both teachers and students. A learning effectiveness testing system and a teaching evaluation system are also constructed to measure the improvement of students' forest fire management skills and the satisfaction of both teachers and students under the diversified teaching modes.

**Keywords:** Forest Fire Management; Diversified Teaching Modes; Evaluation System.

## 1. Introduction

Forest fire management primarily deals with forest fires, and applies principles of physics and thermodynamics to explain the combustibility of forests, clarify the characteristics of forest fires, study the factors that influence the occurrence and behavior of forest fires, and explore the distribution patterns of forest fires in time and space. Scientific quantification and analysis of the characteristics and patterns of forest fires are the foundation of forest fire management, and an understanding of the rules and regulations governing the use of fire can help to ensure its beneficial effects on human beings and the ecological environment. With the progress of society, forest fire management technology has achieved numerous breakthroughs and achievements, including forest fire warning systems, monitoring systems, and new types of firefighting tools. However, the cultivation of forest fire professionals requires breaking through the traditional teaching mode, exploring new forms of diversified teaching modes, and keeping pace with scientific advances. Improving the teaching mode will provide comprehensive forest fire management talents and scientific and technological support for China's forest fire management.

## 2. Current Status of Forest Fire Management Course Teaching

The forest fire management course covers important foundations and required courses for forest fire personnel, including pre-fire site conditions, fire suppression methods during fire occurrence, and post-fire evaluation, as well as fire prevention, firefighting, and fire assessment. Forest fire management requires a strong combination of theoretical knowledge and practical skills, but traditional classroom teaching models limit the effectiveness of forest fire management education.

The traditional teaching model is lecturer-centered, emphasizing theory over practice and results over process. Preventing forest fires and stopping their spread requires early development of fire prevention measures, taking into account different combustible materials, fire source distribution patterns, and microclimatic factors within the forest. However, traditional teaching methods only provide general methods and measures, lacking specific and targeted guidance. Traditional teaching methods also prioritize cognition over development and memorization over exploration. Forest fire management involves a large amount of content, strong technicality, and complex regulations, yet traditional teaching methods lack accurate control of real-world fire management techniques and inadequate awareness of the range of forest fire management regulations. The selection of fire-resistant and fire-resistant tree species in forest fire management requires consideration of local tree species advantages and the use of tree species burn rate differences, inter-species relationships, and

fire adaptability to achieve effective and sustainable fire prevention. Black fire prevention requires controlling the range of fire intensity during the burning process to avoid runaway fires, reducing the accumulation of combustible materials, and reducing the forest's flammability. Yellow fire prevention requires targeted measures based on the specific hazards to establish firebreaks at strategic locations and determine their width and length to prevent forest fires or their spread. High levels of technical knowledge and experience are required, but traditional teaching methods only provide general measures without addressing the principles of selecting appropriate measures. Traditional teaching methods prioritize teaching methods over learning methods and knowledge over skills. Forest fire management classroom teaching needs to be combined with on-site analysis and practical case studies. The traditional classroom teaching model emphasizes book knowledge and neglects the application of knowledge. The use of book-based classic case analysis teaching is not consistent with the current situation. Post-fire evaluation involves fire investigation overview, fire loss survey, and fire investigation documents, but traditional teaching methods often neglect the importance of post-fire evaluation, leading to low database integrity and impeding forest fire scientific development. At the same time, traditional classroom teaching is limited to textbook content, lacking in-depth thinking and method innovation. Strengthening forest fire management work and exploring teaching models suitable for forest fire management are essential to improve comprehensive forest fire management personnel.

### **3. Exploration of Diversified Teaching Modes**

Diversified teaching is an effective attempt to break through the shortcomings of traditional teaching modes. In the graduate stage, the shortcomings of traditional education modes are manifested in the inadequate teaching content that fails to keep pace with the rapid development of the discipline, the neglect of the student's main role, and the emphasis on the social function of education. The education of forest fire management courses is developing in the context of the new era and the new engineering discipline. Firstly, the traditional education model is changed. Teachers update their educational concepts in a timely manner, guided by teachers, students and dual subjects, and attach importance to the combination of theory and practice.

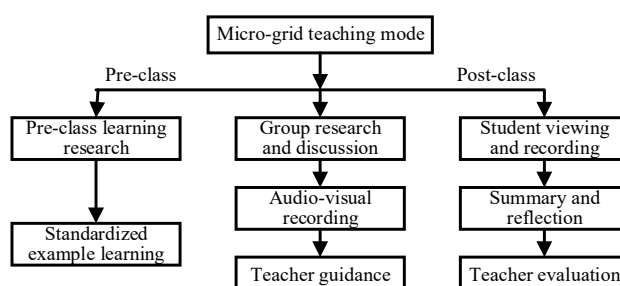
#### **3.1 Teacher-Centered Teaching Mode**

##### **3.1.1 Micro-teaching Method**

Micro-teaching is a teaching mode guided by teachers, which is based on cutting-edge technology theory and uses modern audiovisual equipment to train comprehensive talents in a staged manner according to the feedback principle and teaching evaluation theory, as shown in Figure 1. Micro-teaching breaks down the complex teaching process into single teaching objectives, such as guidance, innovation, discussion, media use, learning strategy guidance, and student academic achievement evaluation, guided by teachers as the main body. Each teaching skill is discussed one by one, and advanced audiovisual equipment and information technology are used to gradually teach students. This teaching mode is suitable for the teaching of fire-fighting technology and fire protection engineering technology in forest fire management courses.

Micro-teaching method clearly defines specific learning objectives, has a small learning scale, records the teaching practice process in audiovisual form, has scientific and reasonable post-effect evaluation, and combines demonstration and innovation through observation. Different from traditional teaching modes, Micro-teaching starts with single teaching skills, formulates scientific teaching plans, and is highly operational, suitable for the teaching process of forest fire management courses from point to surface. Group discussions are conducted with groups of 3-5 people, and each group shares for 10 minutes. The evaluation panel is composed of the guiding teacher and other professionals, showcasing the understanding, mastery, and application of different specialties in forest fire management courses during the teaching process, as well as participating in self-evaluation and peer evaluation of teaching effectiveness. Audiovisual equipment is used to record the teaching

process, and students obtain feedback information from an objective perspective, reflect on and correct their shortcomings, and improve the quality and efficiency of training. After the course, excellent examples are provided to encourage students to actively play a proactive role, innovate on the basis of imitation, embody the flexibility and creativity of teaching, avoid mechanical learning, and shift from linear learning to comprehensive use. A scientific and specific evaluation index system is formulated, and quantitative evaluation and qualitative evaluation are combined to make information feedback diversified and teaching evaluation democratic.



**Fig 1.** Structure diagram of Micro-teaching

SCS Maker Education Method is a teacher-centered teaching mode that uses seven teaching stages - story, copy, state, copy extended, stimulate, cooperation, and share - to gradually increase the level of teaching, as shown in Figure 2. This method enriches the teaching content and promotes the development of students' professional basic abilities, learning methods, and comprehensive application abilities through innovative discussions.

SCS Maker Education Method is suitable for the application of fire in forests, agriculture, and animal husbandry in forest fire management and the discussion of forest fire information decision-making.

The story introduction can inspire students' learning motivation and interest and create a realistic situation close to forest fire management cases, promoting students' thinking collision during the discussion process. After demonstrating a complete forest fire treatment case, students can understand the occurrence of forest fires, the process and measures taken by forest fire management personnel. The detailed and complete case prompts students to imitate and complete the problem-solving process, learning the application of regulations, core knowledge points, and processing methods in forest fire management, and improving their familiarity with the subject. After imitation, the teacher systematically explains and deepens the understanding of knowledge and skills, analyzes the management steps in-depth, and constructs a clear and complete knowledge system framework. Based on the learning case, the teacher combines the teaching difficulties and cutting-edge technology in forest fire management to stimulate and guide students' innovation, cultivating innovative skills and innovative thinking. Members are divided into groups for discussion and cooperation based on their own advantages, and knowledge transfer is achieved through communication, cultivating students' team cohesion and problem-solving abilities. After summarizing the practical process, mutual evaluation and suggestions are made. The teacher, based on the feedback on-site, makes further improvements and refinements.

## 3.2 Student-Centered Teaching Model

### 3.2.1 Case-based Learning

Case-based learning is a teaching method that uses cases as the basis for learning by simulating and reproducing real-life scenarios in which students participate in discussions, as shown in Figure 3. Through analyzing and comparing scenarios in teaching and studying successful and failed experiences, students think and broaden their horizons and enrich their knowledge. Its prominent practicality, objective authenticity, and profound inspiration are suitable for practical operations in

forest fire management, such as emergency plan activation, firefighting plan formulation, post-fire inspection, and recovery measures.

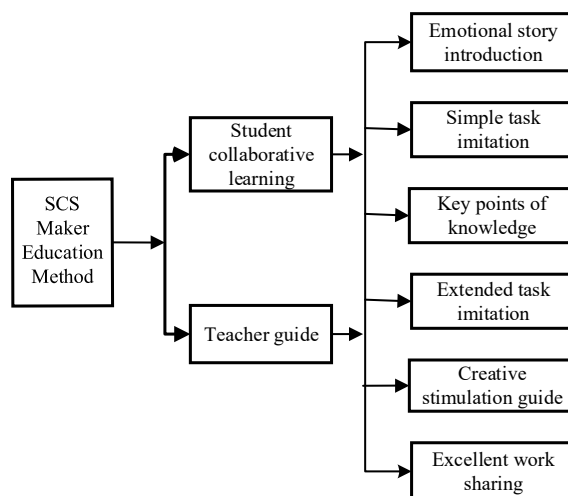


Fig 2. Structure diagram of Creative pedagogy

This teaching mode is divided into four steps: case preparation, group discussion, centralized discussion, and summary. One week in advance, the case material is sent to the students for them to read and analyze, collect relevant regulations and solutions, actively think about processing methods, and preliminarily form the cause analysis and solution for the case problem. At the same time, 3-6 students are divided into a group, fully utilizing brainstorming, discussing with each other and unifying opinions. The group representative publicly presents the group's analysis and processing opinions on the case, with a speaking time controlled within 30 minutes. After the speech, other group members ask questions to expand and deepen the students' understanding of the case. After the centralized discussion, the teacher summarizes and extracts, and the students think and summarize for 10 minutes before class and submit a written conclusion after class. The advantage is that teaching and learning progress together.

In this teaching mode, the teacher controls the teaching process, guides students to think, organizes discussions and research, and summarizes and summarizes; at the same time, it mobilizes students' learning initiative. In teaching, the changing situations and different results presented are conducive to maintaining the best mental state of the students. Secondly, case-based learning is dynamic, specific, intuitive, easy to learn, and has strong authenticity, which is conducive to improving students' practical abilities. It can carry out brainstorming, mobilize the collective wisdom and strength, and broaden horizons.

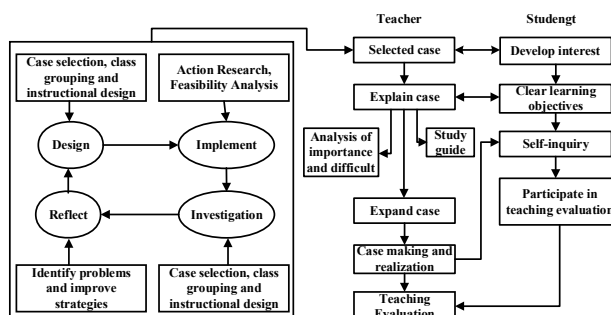


Fig 3. Structure diagram of case driven model teaching

### 3.2.2 Flipped Classroom Teaching

The Flipped Classroom adjusts the time for learning inside and outside the classroom, making the students the main body of the classroom and increasing their active learning and concentration, promoting students' deep understanding and collaborative problem-solving. The Flipped Classroom

model advocates for self-learning before class, reducing the prevalence of general education in the classroom. The teacher uses the key method and collaborative teaching method to teach, allowing students to delve into self-exploration in their learning. The Flipped Classroom model combined with blended learning and inquiry-based learning increases the flexibility, initiative, and participation in learning. The Flipped Classroom teaching model is suitable for teaching theoretical knowledge in forest fire management, such as the basic theory of forest fires, management models, forest fires and the environment, and the ecosystem.

In Flipped Classroom teaching, the early self-learning and knowledge acquisition are convenient, such as the Chinese massive open online courses (MOOCs), Chaoxing Learning, and NetEase Open Courses. The teaching videos are refined, targeted, with clear learning goals, and the length of the videos is within the time range when students' attention can be more focused. The videos have various functions such as pause and playback, which can facilitate independent learning during fragmented time. In the classroom, the teacher deeply explains difficult subjects according to the students' learning foundation, expands students' thinking methods, and promotes internalization and absorption in writing and discussions. Later, reviewing and testing are convenient and fast. The students' weak points in theoretical foundations and problems not understood during after-class thinking are summarized through cloud platforms to help teachers understand students' learning status and answer questions. The students' learning progress can be verified with specific data, which is useful for teachers to understand students' learning status.

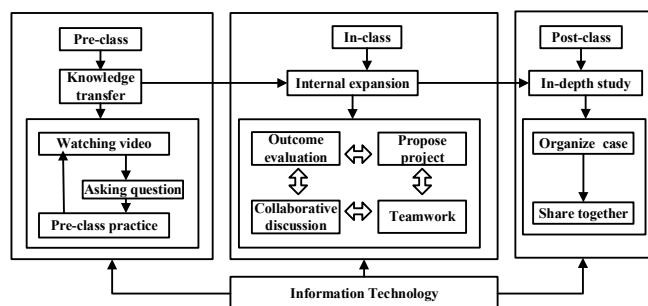


Fig 4. Structure diagram of flipped classroom

### 3.3 Dual-subject Teaching Model

PAD divides teaching into three stages: Presentation, Assimilation, and Discussion, with teachers and students as the dual-subjects. The Discussion stage includes student-to-student discussions and teacher-to-student discussions. The teaching stage is teacher-centered, reducing guided instruction and analyzing cases to improve students' application of theoretical foundations and system construction, and promote the development of comprehensive abilities. The Assimilation stage is student-centered, requiring students to independently learn the learning resources recommended by the teacher, complete the learning tasks assigned by the teacher, and independently think and form their own understanding and learning outcomes. The Discussion stage is conducted in the form of group cooperation. Based on individual assimilation, students share their gains with group members and solve problems together to solve low-level problems and consolidate high-level problems. In the dialogue stage, group representatives report the group's discussion results to the teacher and propose high-level questions. The teacher selectively answers typical questions. PAD teaching method enhances students' critical thinking, innovative thinking, self-regulation ability, and other high-order thinking abilities.

PAD improves teaching efficiency. Different from traditional classroom teaching, teachers in the classroom need to grasp the key points and difficult points of forest fire management content, shorten the time for general education, reduce the pressure of teacher preparation, and promote concentration. Balanced teaching and learning, in the teaching process, the teacher's role changes from simply covering content and imparting knowledge to guiding students' learning, strengthening students' self-directed learning, and improving teaching efficiency. PAD enhances learning ability and improves

student learning efficiency. In the dual-subject teaching model, teachers guide students to further explore and stimulate students' learning enthusiasm. At the same time, the dual-subject teaching model strengthens interactive communication, enlivens the classroom atmosphere, and strengthens interaction between the dual-subjects through group discussion and communication, enhances students' expression ability, inspires each other, promotes each other, deepens understanding, improves learning efficiency, and enhances friendship between classmates and teachers.

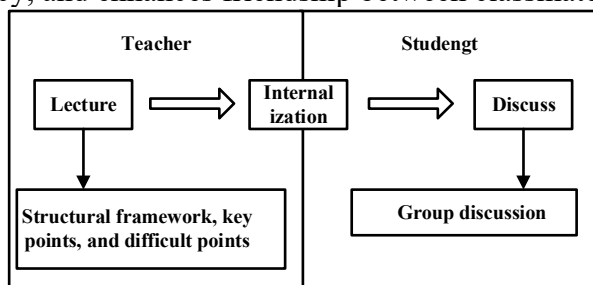


Fig 5. Structure diagram of PAD to split classroom model

#### 4. Building Diversified Teaching Evaluation System

Table 1. Test of theoretical level of forest fire management

Primary indicator	Secondary indicator	Score
Forest Fire Basic Theory A	Forest burning characteristics	10
	Forest combustible characteristics and distribution	35
	Fire source types and distribution	20
	Fire environment analysis	15
	Forest fire behavior	20
Forest Fire and Environment B	Fire impact on soil environment	20
	Fire impact on surface water	20
	Fire impact on atmospheric environment	30
	Fire impact on plants	20
	Fire impact on animals	10
Forest Fire Prevention C	Forest fire administrative management	10
	Forest fire prediction	25
	Forest fire monitoring	25
	Forest fire communication	10
	Forest fire barrier methods	30
Forest Fire Suppression D	Fire extinguishing principles and methods	30
	Forest fire extinguishing methods	20
	Extinction command principles	10
	Common fire extinguishing tools and equipment	10
	Firefighting safety measures	30
Forest Fire Assessment E	Fire Investigation Methods and Principles	40
	Fire Scene Analysis	20
	Fire Traces Survey and Investigation	20
	Fire damage survey	10
	Fire investigation report writing	10
Forest Fire Information Management and Decision Making F	China's forest fire management model	30
	Foreign forest fire management model	10
	Fire statistics and documentation	20
	Forest fire information management system	25
	Macro forest fire management decision-making	15

Different learning effect detection systems are constructed based on different subjects, as shown in Table 1. And a teaching evaluation system is formed, as shown in Tables 2-3. Before and after the semester, students attending the class are tested for their theoretical knowledge level in forest fire management from six aspects, including Basic Theory of Forest Fire Management A, Forest Fire and Environment B, Forest Fire Prevention C, Forest Fire Suppression D, Forest Fire Assessment E, and Forest Fire Information Management and Decision-Making F. The test results M is compared to analyze the effectiveness of different teaching models in terms of students' mastery of theoretical knowledge. The test is quantified in various ways, including noun explanation, multiple-choice questions, simple questions, essay questions, and material analysis questions [8].

**Table 2.** Teacher-centered evaluation system

Primary indicator	Secondary indicator	Score
Teaching Performance G	Completeness of Case Analysis	5
	Emphasis on Teaching Focus	5
	Difficulty of Teaching Content	5
	Combination of Theory and Practicality	5
	Scatteredness of Teaching Content Topics	5
Student Learning Situation H	Understanding of Pre-class Case Materials	5
	Depth of Self-study	5
	Completion of Innovative Case Analysis	5
	Mastery of Post-class Theoretical Knowledge	5
	Retention of Questions	5
Discussion Situation: I	Completeness of Pre-discussion Materials Preparation	5
	Depth of Discussion	5
	Resolution of Discussion Content	5
	Mutual Discussion	5
	Retention of Questions	5
Conclusion Situation J	Self-study Level Before Class	5
	Depth of Summary of Key Points	5
	Depth of Summary of Discussion -	5
	Mastery of Knowledge After Student Discussion	5
	Summary of Questions	5

**Table 3.** Student-centered evaluation system

Primary indicator	Secondary indicator	Score
Teaching Performance G	Satisfaction with Teaching Mode	5
	Degree of Theoretical Explanation	5
	Relevance of Classroom Topics	5
	Degree of Problem Solving	5
	Demonstration of Practical Skills	5
Student Learning Situation H	Effort in Self-study Before Class	5
	Preparation of Materials	5
	Classroom Focus	5
	Participation in Discussion	5
	Depth of Post-class Learning	5
Discussion Situation I	Depth of Intra-group Discussion	5
	Degree of Intra-group Problem Solving	5
	Depth of Inter-group Discussion	5
	Degree of Inter-group Problem Solving	5
	Retention of Questions After Teacher Explanation	5
Conclusion Situation J	Mastery of Knowledge Before Class	5
	Completion of Case Imitation	5
	Depth of Summary of Discussion	5
	Depth of Mastery of Key Points	5
	Resolution of Questions	5

After the course is completed, a teaching evaluation system is constructed for teachers and students as the main subjects, with 40 secondary indicators under four primary indicators: G) teacher's teaching situation, H) student's learning situation, I) discussion situation, and J) summary situation. The results N is calculated and analyzed to evaluate the satisfaction of teachers and students with different teaching models.

Before the start of the course and after the end of the course, a total of 6 tests were conducted to assess the theoretical level of students in forest fire management, and the results were recorded.

$$M = \sum_i^5 A_i + B_i + C_i + D_i + E_i + F_i \cdot$$

After the end of the course, students and teachers evaluated the satisfaction of the course and recorded the results.

$$N = \sum_i^5 G_i + H_i + I_i + J_i$$

## 5. Conclusion

Forest fire management is a multidisciplinary field that encompasses 93 disciplines, including environmental ecology, geology, meteorology, and disaster science. However, there is a shortage of forest fire management talent. To cultivate comprehensive forest fire management personnel with strong practical ability and high theoretical level, it is important to explore the role of diversified teaching methods in forest fire management talent cultivation, focusing on the hotspots of forest fire research and expanding the frontiers of vision. Different teaching modes in the classroom have different levels of subjectivity and teaching methods, which have significant differences in the utility, initiative, and practicality of talent cultivation. Corresponding teaching modes should be adopted for different forest fire management topics to form diversified teaching methods and maximize the teaching effectiveness of forest fire management.

At the same time, diversified teaching methods also have limitations. They strictly require teachers' professional knowledge reserves, practical ability, and their own level of acceptance. Case analysis should be complete and representative, and inter-group discussions should be in-depth and summarizing. It is also necessary to consider guiding talents who are truly interested in forest fire management to participate. However, diversified teaching methods focus on improving the research literacy of forest fire management graduate students, which is in line with the cross-scale and multi-method teaching mode of forest fire management and the current demand for improving the quality of forest fire management personnel in Chinese society.

## Acknowledgments

This work was financially supported by Agriculture and Forestry Working Committee of China Academic Degree and Postgraduate Education Society Fund(2021-NLZX-YB77), Southwest Forestry University Education Fund (YB202104).

## References

- [1] Miao Changcheng, Yang Bo, Yang Qian, Cao Rui. The Impact of Micro-Grid Teaching Method Based on Active Page Textbook Development Concept on Students' Thinking Process in Pathology Course. *Qiqihar Medical College Journal*, 2022, 43(11): 1081-1085.
- [2] Li Xinhong, Huang Weifan. Research on Deep Learning Route under the Concept of Maker Education. *China Metallurgical Education*, 2022(03): 9-13.
- [3] Li Yinlu, Zhang Haihong, Wu Jie. Application of SCS Maker Teaching Method in "Electronic Technology" Course of Higher Vocational Education. *Wireless Internet Technology*, 2021, 18(24): 164-166.

- [4] Wang Fen, Ao Jiayong. A Brief Discussion on Case Teaching Method and Its Application in Teaching Design. Literature Collection, 2018(05): 109-110.
- [5] Liu Wujun, Wang Qiong, Liu Lingling. Research on the Construction of Case Library for Master's Degree Course of "Sheep Production Study" Based on Case Teaching Method - Taking Xinjiang Agricultural University as an Example. University, 2021(39): 39-41.
- [6] Hong Wenjing. Research and Practice of University English Teaching Reform Based on Flipped Classroom. Journal of Heilongjiang Teacher Development Institute, 2022, 41(07): 141-144.
- [7] Zhang Rui, Sun Ruonan, Tian Mi. Study on the Learning Effect Evaluation of Split Class Teaching Mode (PAD). Shaanxi Education (Higher Education), 2021(02): 23-24.
- [8] Jian Wei, Chen Yu, Yu Tingting. Discussion on the Teaching Reform of Forest Fire Course in Colleges and Universities in the New Era. Green Technology, 2020(15): 222-223.