BOPPPS and PAD Class Hybrid Teaching Model

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Abstract

In response to issues such as the disconnection between theory and practice and insufficient student engagement in the teaching of the graduate course "Modern Shortwave Communication Technology," this paper integrates the structured advantages of the BOPPPS model with the interactive mechanisms of the PAD class to construct a hybrid teaching model centered on "goal orientation, intensive lecture and internalization, and interactive deepening." Based on an explanation of the core concepts of this model, a six-step teaching process is systematically designed, with the propagation characteristics of shortwave channels serving as an example to illustrate the specific implementation. Teaching practice demonstrates that this model effectively stimulates students' deep engagement and significantly enhances their analytical skills and innovative thinking in addressing complex engineering problems, providing a viable pathway for cultivating high-quality talent with a solid professional foundation and outstanding practical abilities.

Keywords

BOPPPS Teaching; PAD class teaching; Modern shortwave communication.

1. Introduction

Shortwave communication holds an irreplaceable position in military and emergency communication due to its advantages such as global coverage, flexible networking, and strong survivability. However, its complex channel characteristics, significant influence from the highly non-stationary ionosphere on propagation mechanisms, and severe interference pose numerous challenges in teaching related technologies. "Modern Shortwave Communication Technology," a professional course offered by Naval University of Engineering for graduate students, covers multiple areas including electromagnetic wave propagation theory, modulation and demodulation, and channel coding, requiring strong comprehensive and engineering practical skills. Nevertheless, the course currently faces several issues, such as an extensive curriculum with limited teaching hours, an overemphasis on theoretical instruction with weak practical components, and insufficient development of students' advanced system design and engineering implementation capabilities.

The teaching challenges of the course are primarily reflected in the following aspects: First, the highly non-stationary and time-varying nature of the ionospheric channel makes multipath, fading, and noise modeling difficult. Second, system design requires trade-offs at the link level, such as synchronization and equalization issues in parallel transmission (OFDM) and single-carrier receivers. Third, the real-time performance and stability of adaptive algorithms in real-world environments are challenging to ensure. Fourth, while anti-jamming techniques are diverse, their actual selection and deployment are complex. Fifth, low-frequency antennas face numerous practical constraints in installation and impedance matching. Sixth, networking and

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protocol adaptation under high-latency, unstable channel conditions are highly challenging. These difficulties arise from the deep coupling of physical mechanisms and random processes, the high dependence of system implementation on time-frequency precision, limitations imposed by practical engineering conditions, and the need for real-time decision-making and multi-objective trade-offs.

To effectively address these challenges, there is an urgent need to explore more structured and interactive teaching models. In terms of specific teaching content, it is recommended to adopt a progressive approach from phenomena to theory and from statistical models to practical systems, strengthening the combination of simulation and real-world testing to enhance students' understanding of complex channels and system behaviors. At the same time, it is essential to systematically introduce modern teaching concepts and classroom organization methods, improving teaching efficiency and practical depth through the rational design of teaching segments, enhanced teacher-student and student-student interaction, and the integration of online and offline resources.

For advanced courses like "Modern Shortwave Communication Technology," which are both theoretically profound and highly practical, breaking through the limitations of traditional teaching and effectively unifying knowledge impartation and ability cultivation is crucial. This paper takes the course at Naval University of Engineering as an example and proposes a blended teaching approach integrating BOPPPS and PAD Class. Through this structured and interactive instructional design, the paper aims not only to enable students to deeply understand complex technical principles but also to develop their ability to solve real engineering problems, foster a spirit of collaboration, and cultivate innovation, thereby nurturing top-notch innovative talent for the defense communication sector in the new era.

2. BOPPPS and PAD Class Teaching Philosophy in Graduate Courses

Graduate education differs from undergraduate studies in its core objective: to cultivate students' ability to discover, analyze, and solve complex engineering and scientific problems, as well as to foster their potential for knowledge innovation. Therefore, the teaching philosophy of this course is as follows: using the BOPPPS model as a refined classroom organization framework to ensure the scientific rigor and effectiveness of the teaching process, while deeply integrating the PAD Class approach. Through "responsibility sharing" and "cross-class discussions," students are guided to construct a systematic understanding of modern shortwave communication in autonomous exploration and deep critical thinking, thereby stimulating their critical thinking and innovative research capabilities.

2.1. BOPPPS Teaching Philosophy

The BOPPPS model, as a modular instructional design framework, centers on the effective transmission of teaching objectives through structured interactive processes. This model is particularly well-suited to graduate courses that demand both academic depth and intellectual stimulation—it neither relies on one-way knowledge transmission nor settles for unstructured discussions. Instead, it constructs an inquiry cycle focused on core issues through a logical chain of "objective orientation, bidirectional interaction, and continuous feedback." In graduate classrooms, the model emphasizes building on students' prior academic foundations (pre-assessment), facilitating cognitive leaps through carefully designed participatory learning, and ultimately guiding students to transition from knowledge recipients to knowledge constructors. The closed-loop structure formed by its six phases essentially embodies the "learning-centered" philosophy of higher education, making it especially suitable for graduate teaching contexts that require a balance between theoretical instruction and research capacity development.

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Specifically, the six phases of BOPPPS form a progressively advancing teaching chain:

Bridge-in requires instructors to create a cognitive context using cutting-edge academic questions or research cases, stimulating graduate students' curiosity for inquiry.

Objective involves clearly articulating expected outcomes in knowledge systems, research methods, and academic thinking, providing guidance for advanced learning.

Pre-assessment quickly diagnoses students' existing understanding of the topic, allowing for dynamic adjustment of teaching depth.

Participatory Learning, as the core of the model, requires the design of immersive tasks such as group project discussions, critical analysis of literature, or experimental design, enabling students to construct knowledge through academic practice.

Post-assessment evaluates whether the objectives have been achieved through research proposal presentations, academic debates, or reflective reports.

Summary distills the course’s knowledge framework and methodological insights while establishing connections to subsequent research topics.

In the context of graduate education, the essence of the BOPPPS model is reflected in three dimensions:

The objective-first principle, which translates academic competency development into observable behavioral indicators.

The embedded evaluation mechanism, which integrates teaching assessment throughout the process rather than treating it as a final judgment.

Most importantly, the design of participatory learning, which cultivates graduate students' abilities to identify problems, select methods, and construct academic arguments through task-driven activities that simulate real research scenarios.

When graduate students experience the complete research chain—"literature review → problem identification → solution design → outcome presentation"—in the classroom, they gain not only structured knowledge but also transferable academic competencies. This design intelligence, which integrates teaching content, research methods, and cognitive training, is precisely where the value of the BOPPPS model lies in transforming graduate courses from "knowledge transmission" to "academic incubation."

2.2. PAD Class Teaching Philosophy

The core principle of the PAD Class model lies in its structural division of classroom time, separating the teacher's systematic instruction from students' internalization and peer discussion. Fundamentally, it restructures the temporal sequence of "teaching" and "learning" to achieve a deep integration of knowledge delivery and cognitive development. This approach strongly aligns with graduate education's emphasis on cultivating academic critical thinking and independent inquiry. Rather than a simple time allocation, it employs specific formats like "cross-class discussion" or "in-class PAD" to intentionally create dedicated space for independent reflection, effectively addressing the superficial thinking often seen in traditional seminars due to impromptu speaking. Through the "Lecture–Independent Learning–Discussion" cycle, the PAD Class aims to develop graduate students' holistic academic competence—encompassing "listening, reflecting, constructing, and debating"—thereby transforming them from passive knowledge recipients into active interpreters and co-creators.

In graduate teaching practice, the PAD Class demonstrates distinct advantages. The instructor's concise preliminary lecture outlines a clear theoretical framework and academic frontiers, ensuring focused and efficient self-directed learning. The subsequent "internalization" stage requires students to independently engage with literature, digest knowledge, and form personal insights—a crucial phase for developing critical thinking and independent research skills. The peer discussion segment not only sparks new academic inspiration through the

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exchange of ideas but also simulates common scenarios of collaboration and debate within academic communities, effectively enhancing graduates' abilities in scholarly expression and logical argumentation. This process shifts the traditional emphasis on concentrated input during class to a distributed, graduated approach to knowledge construction, thereby profoundly fostering the growth of graduate students' academic autonomy and innovative capacity.

3. Blended Instructional Design: Integrating BOPPPS and PAD Class in Graduate Education

3.1. Inspirational Guidance and Forward-Looking Objectives

At the beginning of the lesson, the teacher uses a challenging question, a brief case study, or a cognitive conflict closely related to the previous unit or real-world context to spark students' interest, naturally bridging prior and new knowledge. This design aims to activate students' existing knowledge reserves and set a clear direction for the upcoming learning. Following this, the learning objectives for the lesson are clearly articulated, with special emphasis on their position within the overall course framework—they serve as a natural extension of previous learning and as a foundation for subsequent group discussions and knowledge application, thereby imbuing learning with continuity and purpose.

3.2. Diagnostic Pre-Assessment and Framework-Based Elaboration

The pre-assessment phase is designed to accurately diagnose students' cognitive starting points. Through one or two key multiple-choice questions, a short written response, or a quick electronic survey, the teacher gauges students' understanding of fundamental concepts. Based on this feedback, the teacher proceeds with "elaboration," focusing on constructing a framework and leaving room for guidance. The teacher concentrates solely on explaining core concepts, theoretical contexts, and key challenges thoroughly, building a solid knowledge skeleton for students rather than covering every detail. Simultaneously, students are explicitly informed that richer details, examples, and deeper understanding will require independent exploration in subsequent stages, thus reserving space for internalized learning.

3.3. Immediate Internalization and Preliminary Discussion

After elaborating on the core content, a brief "in-class integration" session is immediately incorporated. The teacher poses a targeted thinking question or mini-task designed to facilitate the immediate application of knowledge. Students first engage in independent silent thinking and preliminary organization, marking the beginning of the internalization process. Subsequently, students form small groups with nearby peers to exchange their views and initial conclusions. This immediate interaction not only reinforces the newly learned knowledge framework but also sparks new thinking through intellectual exchange. The teacher circulates to provide guidance and identifies common questions, offering a clear path for post-class deep internalization.

3.4. Driven Post-Assessment and Autonomous Internalization

The post-assessment is designed as a transitional, driven task. It typically involves a moderately comprehensive assignment to be completed independently by students after class, such as analyzing a mini-case, solving a practical problem, or elaborating on core concepts. This task serves to assess students' understanding of the "knowledge skeleton" taught in class while its core function is to drive the most critical "autonomous internalization" phase. Students are required to consult materials, think independently, and flesh out the classroom skeleton with substance, forming personal insights and preparing thoroughly for higher-order discussions in the next class.

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3.5. Structured Summary and Agenda-Based Preview

At the end of the lesson, the teacher provides a structured summary, not merely repeating content but reinforcing the lesson's knowledge framework and core ideas to help students grasp the key points from a macro perspective. More importantly, the teacher clearly outlines the specific requirements for the post-class internalization task and explicitly previews the core agenda for the next lesson—it will build on the current assignment to conduct in-depth group discussions or case studies. This approach aims to conclude the current lesson while setting the stage for the next "elaboration-internalization-discussion" teaching cycle, ensuring continuity in the learning process and students' psychological readiness.

3.6. In-Depth Discussion and Cyclical Elevation

In subsequent classes, the teaching directly transitions into a student-led in-depth discussion phase. Class time is first allocated to small groups, allowing students to exchange, debate, and collaborate on the results of their post-class internalization—completed assignments or prepared viewpoints—to collectively address more challenging questions. Subsequently, groups share their insights, while the teacher guides the direction, clarifies logic, addresses common difficulties, and provides necessary supplements and elevation. Finally, quick formative assessments are used to evaluate the outcomes of the discussion and naturally introduce new learning topics. In this way, the rigorous structure of BOPPPS and the deep interaction of the integrated classroom cycle continuously propel learning to higher levels.

4. Examples of Blended Teaching Integrating BOPPPS and PAD Class in Graduate Courses

Taking the graduate course "Modern Shortwave Communication Technology" as an example, and based on the blended teaching philosophy and design approach of BOPPPS and PAD Class. As shown in Figure 1, the following is the corresponding implementation case for the course.

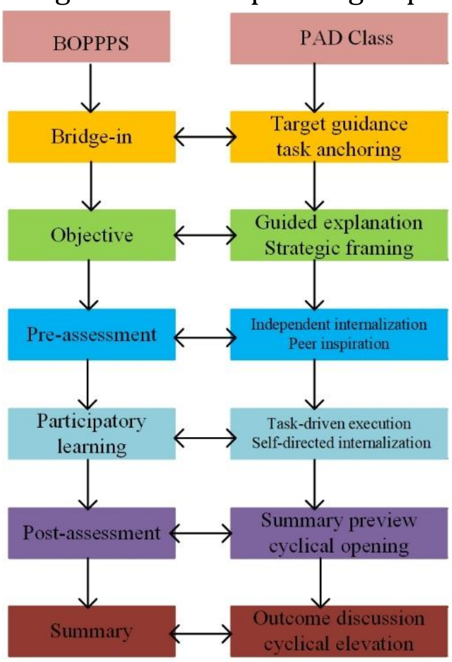

Figure 1. Flow Diagram

4.1. Creating Context and Establishing Objectives

The course begins with an emergency rescue scenario: a recording of a rescue team in a remote mountainous area successfully making contact via a shortwave radio. The teacher then poses a core question: "Under conditions without base stations or satellite signals, why can shortwave

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achieve long-distance communication? What is the fundamental difference between this and the mobile communication we use daily?" This real-world case immediately connects abstract theory to practical value. Based on this context, the teacher clearly states the lesson's objective: to master the physical mechanisms of shortwave ionospheric propagation and the four typical modes. It is emphasized that this understanding is essential for the practical link design in the next lesson, providing students with a clear learning direction.

4.2. Diagnosing Learning Readiness and Building a Framework

The teacher initiates a diagnostic assessment through an instant poll: "Which of the following do you think is the main mechanism for long-distance shortwave transmission? A. Direct wave B. Surface wave C. Ground-reflected wave D. Ionospheric-reflected wave." The poll results visually reveal students' misconceptions. Addressing these misconceptions, the teacher delivers a focused lecture on the core role of the ionosphere. Using dynamic diagrams, the teacher explains the layered structure of the ionosphere and the mechanism of radio wave refraction, succinctly covering key concepts such as critical frequency and maximum usable frequency. The teacher intentionally leaves gaps, such as not delving into the details of day-night variations, to build a clear theoretical framework and guide students to independently fill in the details after class.

4.3. Immediate Application and Stimulating Critical Thinking

After teaching the core theory, the teacher immediately sets a decision-making task: "As a communication officer, when establishing contact from Beijing to Xinjiang, which layer of the ionosphere would you primarily rely on during the day and at night? Please explain the reasoning behind your decision." Students first analyze the problem independently, followed by group discussions. This immediate application环节 prompts students to quickly apply the newly learned layered theory to solve a practical problem. During the discussions, debates naturally arise regarding the dominant roles of the E-layer and F-layer during day and night. Through this process, students not only consolidate their knowledge but also develop the ability to think critically about engineering decisions. The teacher, meanwhile, identifies common doubts by circulating among the groups.

4.4. Deepening Understanding and Driving Internalization

The post-lesson assessment for this class is designed as a comprehensive research task: "Independently analyze the formation mechanisms and characteristics of the four phenomena—skywave, ground wave, multi-hop propagation, and the silent zone—and illustrate them with diagrams. Furthermore, provide an in-depth explanation of why more shortwave radio stations can be received at night." This assignment requires students to integrate the knowledge from the lesson. By independently consulting resources, creating schematic diagrams, and writing analytical reports, students complete the transition from theoretical understanding to comprehensive application. This process is a crucial internalization stage in this teaching model, laying a solid foundation for collaborative learning in the next lesson.

4.5. Consolidating Core Concepts and Connecting Past to Future

At the end of the lesson, the teacher systematically reviews the content using a knowledge map, retracing the complete logical chain from ionospheric structure to propagation modes, and re-emphasizing the critical roles of frequency selection and environmental factors. Subsequently, the teacher clearly assigns the internalization task and previews the agenda for the next lesson: "The independent research reports you complete will be the core material for the next lesson. You will work in groups to apply these findings to solve a real-world 'plateau silent zone'

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communication challenge." This design brings the current lesson to a satisfactory close while paving the way for a new learning cycle.

4.6. Collaborative Innovation and Integrating Knowledge with Practice

In the new class session, learning directly moves into the application phase. Each group engages in professional discussions centered around the engineering problem of "designing a shortwave communication solution for plateau regions," based on the in-depth research reports they have completed. During the solution presentation phase, different groups exchange and debate key technical approaches such as frequency selection and the application of multi-hop modes. The teacher guides students in refining their solutions and summarizes universal design principles. Finally, by introducing a new challenge—"how to overcome shortwave channel fading"—the lesson naturally transitions to the teaching unit on anti-interference techniques, achieving continuous knowledge deepening and skill advancement.

5. Conclusion

The implementation of the blended teaching model based on BOPPPS and PAD Class in the "Modern Shortwave Communication Technology" graduate course demonstrates that this innovative pedagogical approach offers a new pathway for cultivating high-level communication talents. By organically integrating the structural advantages of BOPPPS with the interactive features of PAD Class, the course has established a complete teaching cycle of "guidance-intensive instruction-internalization-discussion-deepening." Practice has proven that this teaching model not only effectively addresses the disconnection between theory and practice in traditional graduate education but also achieves remarkable outcomes in the following aspects: students' autonomous inquiry abilities undergo systematic training, knowledge transfer and innovation capabilities show substantial improvement, and teamwork and academic communication skills are strengthened through ample critical thinking interactions. Looking ahead, this course will continue to explore teaching strategies that deeply integrate theory and practice, striving to establish a more scientific multidimensional evaluation system, thereby better serving the comprehensive development of graduate students' research literacy and innovative capabilities.

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