# The Exploration and Practice of BOPPPS-based Blended Teaching in Power System Analysis Course Based on OBE Philosophy

Jiayang Tong

Huzhou College (Institution of intelligence), Huzhou, 313000, Zhejiang, China

chntong@hotmail.com

**Abstract.** The "Power System Analysis" course is a core module in the Electrical Engineering and Automation program. In the context of applied undergraduate institutions, and in response to the development needs of the power industry and local economic growth, a teaching system characterized by "one center, two drives, and four progressions" has been explored to address real issues in teaching. This system is "student-centered," driven by "learning teams and engineering practice," and progresses through four levels: foundational, expanding, application, and shaping. The BOPPPS classroom teaching model and multidimensional and diversified evaluation system have been developed. Course knowledge points are logically linked into a chain, integrating advanced knowledge with engineering applications to form a knowledge map of the course. By utilizing online platforms and real engineering cases, the teaching content has been redesigned to incorporate diverse engineering elements. The ideological and political education model was reformed and reinforces moral education. The innovations in the course have yielded positive results, significantly increasing students' employment rates in the power grid sector and enhancing their overall qualities, innovative capabilities, and entrepreneurial skills.

**Keywords:** Blended learning, BOPPPS, OBE philosophy, Power system analysis

## 1 Introduction

### 1.1 Concept of BOPPPS-based Blended Teaching

The BOPPPS (Bridge-in, Objective, Pre-assessment, Participatory learning, Post-assessment, and Summary) teaching model was originally proposed by ISW (Canadian Teacher Skills Training Workshop) for teacher training operational skills and was later cited in multiple fields [1]. BOPPPS is an instructional design model that enhances teaching effectiveness by structuring lessons around six key components: Bridge-in, Objective, Pre-assessment, Participatory Learning, Post-assessment, and Summary. It begins with a Bridge-in to connect students' prior knowledge to the new content, followed by clearly defined Objective that outline what students should achieve by the end


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of the lesson. A Pre-assessment evaluates students' existing knowledge, leading into Participatory Learning, where students engage in active, collaborative learning activities. Afterward, post-assessment measures understanding through quizzes or discussions, and finally, a Summary reinforces key points and concepts, helping students consolidate their learning [2].

Blended teaching, or blended learning, combines traditional face-to-face instruction with online learning elements, creating a flexible and effective educational experience [3]. This approach allows students to access online materials at their convenience, enabling self-paced learning while leveraging diverse digital tools like videos and interactive simulations alongside traditional lectures [4]. By enhancing engagement through interactive activities and collaborative projects, blended teaching fosters personalized learning experiences and facilitates continuous assessment through online quizzes and assignments. Finally, this method aims to improve learning outcomes by creating a dynamic and responsive educational environment [5].

### 1.2 Concept of New Engineering and OBE philosophy

The Ministry of Education's Higher Education Department in China has outlined the New Engineering initiative as a new concept for engineering education, characterized by a new structure in disciplines, new talent cultivation models, improved educational quality, and a newly classified development system. The essence of New Engineering is guided by moral education and aims to cultivate diverse and innovative engineering talents through inheritance, innovation, cross-disciplinary integration, and coordination.

New Engineering represents an organic combination of new concepts, models, methods, and content, emphasizing moral education and innovative, coordinated, green, open, and shared engineering education views.

The OBE (Outcomes-Based Education) philosophy, a fundamental concept in engineering education accreditation, focuses on the abilities students acquire after education [6]. OBE advocates a results-oriented approach, centering on students, and employs backward design in curriculum development to create a nurturing platform. This philosophy aligns closely with the goals of talent cultivation, making it relevant in the context of New Engineering [7].

In applied undergraduate institutions, the employment rate of graduates is a crucial evaluation metric, reflecting students' concerns about post-graduation employment, which coincides with the OBE philosophy. Feedback on employment quality necessitates regular adjustments to professional training plans and objectives, keeping the training system dynamic and continuously improving.

### 1.3 The Application of BOPPPS and OBE in the Teaching of Power System Analysis Course

BOPPPS-based blended learning integrates the BOPPPS instructional model into a blended learning framework, enhancing both online and face-to-face educational experiences. In the teaching of "Power System Analysis", this method promotes active engagement, flexibility, and personalized learning, leading to improved student outcomes in theoretical foundation, learning ability and ability to solve engineering problems. This structured approach promotes active participation and ensures that teaching aligns with learning objectives, ultimately improving student outcomes.

Achieving talent cultivation goals ultimately correlates with the knowledge, qualities, and abilities developed in each course. "Power System Analysis" is a comprehensive course in the Electrical Engineering and Automation program, integrating circuit theory, analog circuits, electromechanics, and electromagnetics, and balancing theoretical and practical aspects. This course serves as a foundation for students' understanding of power systems and underpins advanced courses such as "Relay Protection in Power Systems," "Automation of Power Systems". It primarily focuses on steady-state flow analysis and the optimization of frequency and voltage levels, making its design critical for developing students' theoretical knowledge and engineering practice abilities. Reforming this course will solidify the professional competence of students in power systems and enhance their data analysis and experimental skills, which enhances their employment competitiveness. Therefore, under the guidance of OBE philosophy, active teaching reform and design are essential for cultivating high-quality applied engineering talents.

## 1.4 Analysis of Current Course Teaching Status

In the context of local applied undergraduate institutions, the goal is to cultivate high-quality applied engineering talents. The "Power System Analysis" course is aimed at third-year students in the Electrical Engineering and Automation program, who have completed foundational courses such as circuit theory and analog electronics. While these students possess a certain knowledge base and are adept with modern learning tools, they are often unfamiliar with high-voltage courses, exhibiting weak systematic thinking. Their learning tends to be limited to textbook knowledge, resulting in a lack of tangible outcomes, and they often passively receive information rather than actively engage in learning.

After years of practical exploration, the core challenges in this course have become evident: in the context of new power industry developments, how to cultivate talent that is "good at learning, thinking, acting, and being virtuous"? The specific issues are as follows:

### 1.4.1 Student-Centered Learning Needs Enhancement.

The current teaching approach primarily involves teacher-led instruction, with limited interaction between students and teachers. Opportunities for students to actively learn and showcase their understanding are insufficient. Additionally, assessments are predominantly exam-based, hindering students' intrinsic motivation to learn and impeding genuine knowledge transfer.

#### 1.4.2 Integration and Application of Knowledge Requires Improvement.

As a highly specialized theoretical course, "Power System Analysis" covers complex and abstract theories across various aspects of power production and transmission. This includes interdisciplinary knowledge points that make it difficult for students to focus their learning, hindering the development of systematic thinking and deep understanding.

#### 1.4.3 Practical Application Needs Implementation.

The intrinsic high-voltage nature of power systems limits the ability to conduct hands-on experiments in the classroom. This results in verification experiments for isolated knowledge points, preventing students from experiencing the practical application of course content and from effectively simplifying and analyzing complex engineering problems using their knowledge. Moreover, the lack of ideological and value guidance in teaching makes it challenging to cultivate high-quality engineering professionals.

From these issues, students lack practical ability development and pathways for enhancing their overall competencies. Therefore, a primary objective of this project is to deeply integrate the New Engineering philosophy with professional course teaching and the cultivation of high-quality applied engineering talents, thereby improving students' moral development and employment quality. Currently, this teaching model is still in its early stages, making research into this new topic both meaningful and necessary.

## 2 Course Reform Ideas

In response to the pain points encountered during the teaching process, the course team has developed a "One Center - Two Drives - Four Progressions" blended teaching system (figure 1.) that emphasizes teamwork and highlights engineering practice to cultivate engineering talents that meet the demands of the new era.

One Center: Focus on students, emphasizing their central role in the learning process.

Two Drives: Driven by learning teams and engineering practice, this approach organically integrates engineering cases and teaching resources. It fully utilizes information and visualization tools for learning analysis, builds learning teams, and emphasizes the development of engineering practice and teamwork skills, fostering student autonomy in learning.

Four Progressions: Ensures effective achievement of teaching goals from four perspectives: knowledge transfer, higher-order Knowledge application, skills training, and value guidance.

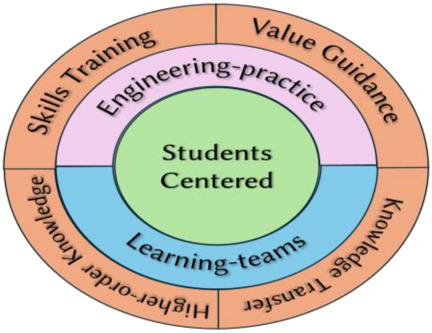


**Fig. 1.** The ‘one center, two drives, four progressions’ teaching system

Through this four-tier capability progression model, students are encouraged to "learn well, think well, act well, and be virtuous," effectively addressing the key challenges faced by the teaching team during the course iteration process.

# 3 Course Innovation Measures

## 3.1 Based on the concept of OBE, the curriculum Objectives in Line with The Training of Applied Talents Are Formed

In the context of local application-oriented undergraduate institutions, this course aims to cultivate high-quality applied engineering talents with the following objectives: first, to solidify theoretical foundations by enabling students to master the basic theories and methods of power system analysis, thus enhancing their ability to apply electrical theories to solve engineering problems and laying a solid groundwork for future studies; second, to strengthen professional qualities by obtaining practical engineering cases through school-enterprise collaboration and designing relevant course tasks that encourage students to autonomously tackle complex technical issues, thereby subtly improving their professional skills and training students to effectively collaborate in multidisciplinary teams; finally, to enhance comprehensive qualities by integrating online ideological education resources with offline teaching to foster students' political, ideological, and cultural recognition, build professional and cultural confidence, instill a spirit of craftsmanship, and develop an ethical perspective as engineers, ultimately elevating students' overall quality.

## 3.2 Creating BOPPPS-based Classrooms with Diverse Evaluation Methods

The course team adopts a student-centered approach by leveraging online resources to redesign the classroom model, blending "online self-learning" and "offline interactive discussions" through a BOPPPS-based blended teaching method as shown in figure 2.

This approach encourages students to engage in independent learning, innovation, and knowledge transfer.

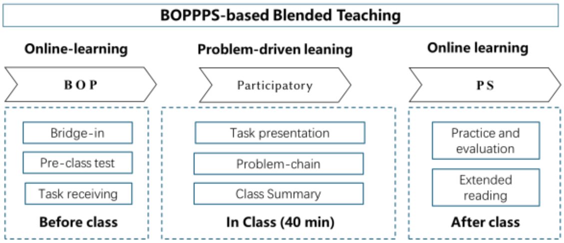


**Fig. 2.** The BOPPPS-based Blended teaching method

Figure 3 shows the evaluation system of the course, which comprising Final Grades (50%) and Regular Performance (50%). The regular performance was further divided into components such as Online test (10%), Course work (10%), Course design reports (15%), Classroom discussions and presentations (10%), and team mutual evaluations (5%). This multifaceted evaluation ensures students are actively participating both online and offline, enhancing their overall learning experience.

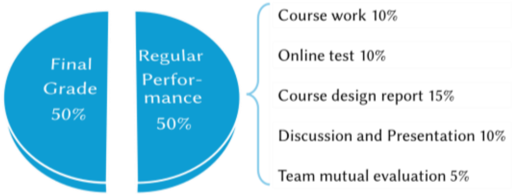


**Fig. 3.** The evaluation system

### 3.3 Developing a New Knowledge Framework

The course knowledge is systematically deconstructed and reconstructed into a problem chain, enhancing understanding and application. By incorporating advanced industry technologies, students delve into the technical aspects of knowledge points, facilitating practical applications through engineering design. This process results in a knowledge network that bridges theoretical foundations and advanced applications, fostering systematic thinking. An online course platform (SPOC) supports this with over 700 minutes of video content and four resource repositories focused on ideological education, advanced knowledge, application cases, and exam questions.

### 3.4 Emphasizing Practical Teaching Content in Power Engineering

A corresponding practical course—Engineering Project Design Training—has been established in the course practice section. With the help of a senior engineer from the State Grid, the instructors will modify and improve design task documents related to actual engineering cases in power systems, creating course design tasks suitable for undergraduates. These tasks will set up engineering problems closely related to industry needs, allowing students to explore and collaborate on solutions. For example, designing the electrical system for a local food production factory, which involves a task document, in which the load conditions of various workshops, the plant layout, the geographic information and the basic electrical design requirements were given. Based on the given conditions, students need to use the knowledge from the course to solve multiple industry problems, including calculating the capacity of each workshop, the local substation and the short-circuit capacity of the supply lines, obtaining the overall daily electricity costs of the factory, finally using AutoCAD to draw the factory electric system layout plan. This design requires students to be familiar with at least one classic load calculation method and reactive power compensation calculations, to reasonably select substation locations and the models of transformers and other hardware, and to analyze the potential impacts of various faults on the system. Ultimately, students will compile a course design report and give a reasonable layout of the electric design. This heuristic practical training helps students better grasp theoretical knowledge from the classroom, cultivates their ability to apply interdisciplinary knowledge, enhances their enthusiasm for learning, and fosters a meticulous and serious work attitude.

In addition, we established a partnership with the State Grid Training Center to arrange internships for students at power companies and grid units, creating a joint guidance system with corporate mentors and on-campus instructors. This builds a multidimensional training system, further deepening students' understanding of the theoretical knowledge learned in class and their recognition of actual power systems.

### 3.5 Reforming Teaching Methods of Course-based Ideological and Political Education

The course team integrates ideological education within professional teaching by focusing on the values of "New Era Electricians." This involves optimizing the curriculum and lesson plans to seamlessly incorporate ideological elements, using methods such as concise teaching of key concepts with ideological highlights, thematic discussions on current events, and project-based tasks that promote responsibility and teamwork. The SPOC platform and analytical tools enhance the integration and evaluation of ideological education, supported by a resource library that includes alumni stories and industry codes of conduct.

## 4 Course Innovation Outcomes

### 4.1 Increased Sense of Belonging

The number of graduated students entering power-related enterprises rose significantly, with 24% of graduates finding jobs in 2023, a notable increase compared to the previous two years. This indicates that the course reform aligns with the spirit of the OBE philosophy.

### 4.2 Enhanced Student Engagement

There has been a marked improvement in student engagement, initiative, and inquiry skills. According to pre - and post-reform questionnaires，the results was shown in figure 4. It demonstrates that over 90% of students reported enhanced abilities in active learning, teamwork, and literature retrieval skills. Approximately 85% noted improvements in innovative inquiry, critical thinking, and communication, while nearly 80% felt their systemic thinking had strengthened.

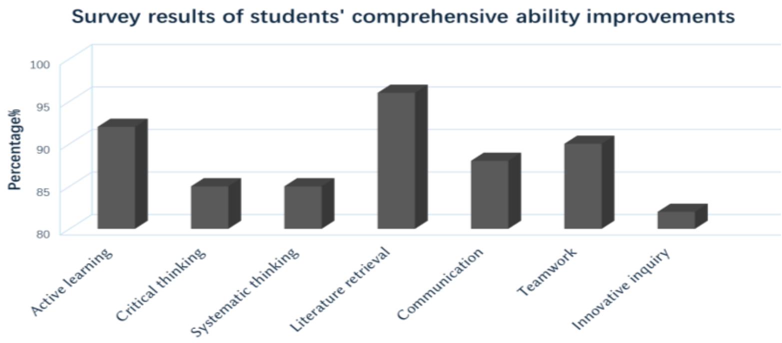


**Fig. 4.** the survey results

### 4.3 Increased Social Service Awareness

Through teaching, students have embraced the spirit of electrical engineering, applying their knowledge for community service. Students spontaneously set up the "Electric Control Competition Club," which organized over ten community service activities in the past three years, benefiting more than 500 individuals.

### 4.4 Strengthened Innovative Inquiry Skills

Participation in research and competitions has increased annually. The students' club hosts various competitions, engaging many students. Achievements include two national second prizes in the National College Student Intelligent Vehicle Competition, two provincial second prizes in the Siemens National Intelligent Manufacturing Challenge and won third place in the 17th Higher Education Cup National University Advanced Drawing Technology Competition and secured three provincial innovation and entrepreneurship project.

## 5 Conclusion

The implementation of the "One Center - Two Drives - Four Progressions" BOPPPS-based blended teaching model in the "Power System Analysis" course has yielded significant improvements in both teaching effectiveness and student outcomes. By prioritizing student engagement and developing a collaborative learning environment, the course has enhanced students' sense of belonging, increased their initiative and inquiry skills, and deepened their social service awareness. Furthermore, the integration of real-world engineering practices and ideological education has enriched the learning experience, empowering students to apply their knowledge effectively in professional contexts. As evidenced by the rising employment rates in the power industry and students' achievements in competitions, the course reform has successfully cultivated high-quality engineering talents, aligning with the evolving demands of the electrical engineering field. Moving forward, these innovative practices can serve as a model for other programs aiming to enhance student learning and industry relevance.

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## References

1. He, Huiqian & Zhang, Gaomei & He, Yuan. 2022. Design courses based on BOPPPS teaching mode. SHS Web of Conferences. 145. 01020. 10.1051/shsconf/202214501020.
2. Xiong, Ming. 2023 "The application of BOPPPS teaching model in online and offline hybrid Civics teaching in universities." Applied Mathematics and Nonlinear Sciences 9: n. pag.
3. Ma, X., Zeng, D., Wang, J., Xu, K., & Li, L. 2022. Effectiveness of bridge-in, objective, pre-assessment, participatory learning, post-assessment, and summary teaching strategy in Chinese medical education: A systematic review and meta-analysis. Frontiers in medicine, 9, 975229. https://doi.org/10.3389/fmed.2022.975229.
4. Rosales Asensio, E., Sierra, C., Pérez Molina, C. et al. 2021. Teaching Using Collaborative Research Projects: Experiences with Adult Learners in Distance Education. Sustainability,13(18).
5. Zhang, D., Tian, J., Goh, H. et al. 2022. The Key Technology of Smart Energy System and Its Disciplinary Teaching Reform Measures. Sustainability,14(21). https://doi.org/10.3390/su142114207.
6. Rao Li, 2021. Research on the reform of practical courses from the perspective of "OBE" and "BOPPPS" [J] Contemporary Education Practice and Teaching Research (Electronic Journal), 2021 (20): 107-109.
7. Andrew, V., Iouri, B., Margaret, H. et al. 2019. Creativity in Electrical Engineering Degree Programs: Where Is the Content? IEEE Trans. Education,62(4). https://doi.org/10.1109/TE.2019.2912834.