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An Innovative LabVIEW-Based Blended Teaching Model for Communication Principles

Dan Liu, Hui Zhang, Shanna Zhu*

School of Physics and Information Engineering, Guangdong University of Education, Guangzhou 510303, China

****Author to whom correspondence should be addressed.***

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Abstract: To address the abstract nature of the Communication Principles course, the insufficient integration of theory and experiment, and the limitations of conventional assessment, a blended teaching model integrating Xuexitong, LabVIEW, and NI ELVIS II+ was developed. Centered on LabVIEW-based dynamic simulation, the model connects pre-class preparation, in-class inquiry, experimental practice, and post-class reflection, while combining formative and summative assessment. Teaching practice indicates that the model helps shift students' learning from a primary focus on formula-based calculations toward parameter analysis and system design.

Keywords: Communication principles; LabVIEW; Blended teaching; PAD class; Experimental teaching

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1. Introduction

The Communication Principles course involves many abstract concepts, while conventional teaching relies heavily on mathematical derivations and verification-oriented experiments, making it difficult for students to connect theoretical models with observable system behavior. Previous studies have shown that blended learning and active learning can promote understanding and application of knowledge, while LabVIEW and virtual laboratories have been widely used in engineering education and related courses [1-3]. However, many existing practices focus on isolated components such as online learning resources, virtual simulation, or laboratory instruction, with limited continuity among theoretical teaching, simulation-based inquiry, hardware experiments, and course assessment. To address this issue, the present study integrates Xuexitong, PAD Class, LabVIEW, and NI ELVIS II+ to construct a blended teaching model spanning the entire learning process.

2. Design of the blended teaching model

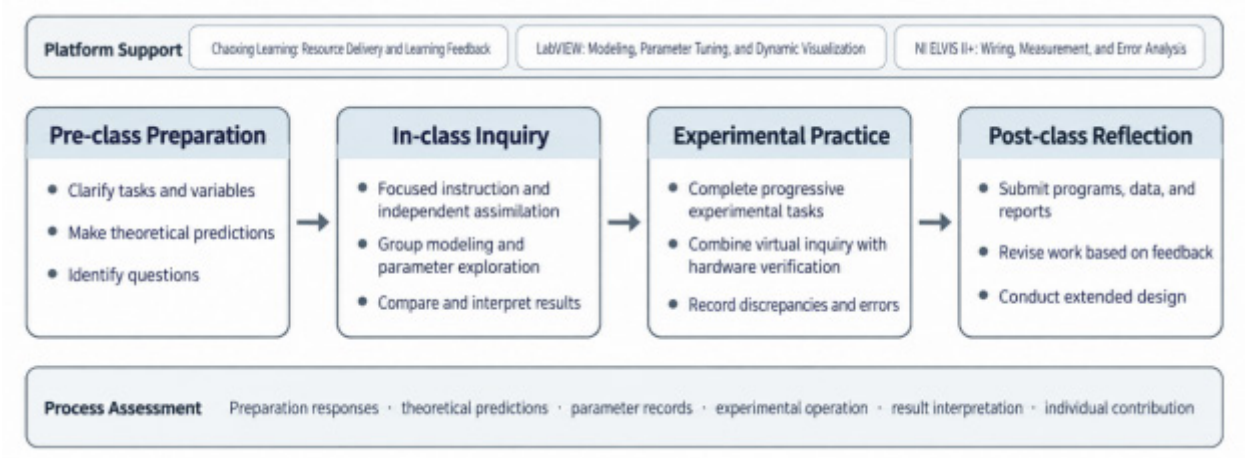


Figure 1. Framework of the LabVIEW-based blended teaching model for Communication Principles.

The course follows a closed-loop process consisting of "pre-class preparation–in-class inquiry–experimental practice–post-class reflection", as shown in **Figure 1** [4,5]. Xuexitong is used for learning resources and task management, LabVIEW for simulation-based inquiry, and NI ELVIS II+ for hardware verification, thereby linking theoretical analysis, virtual simulation, and experimental practice [6].

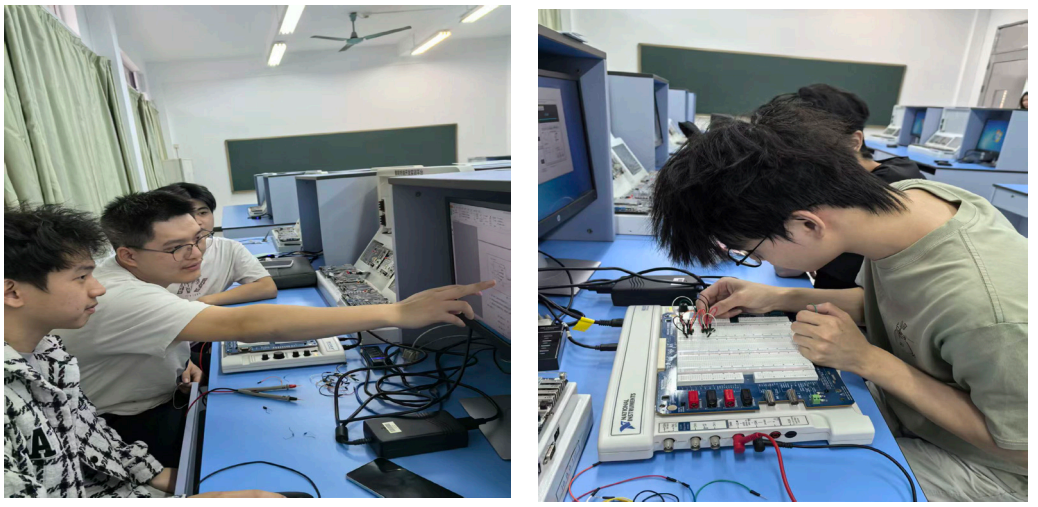
Before class, students access short videos, preparatory questions, and simulation tasks through Xuexitong. They first make theoretical predictions and then use LabVIEW to verify them and record any questions that arise [7]. In class, the Presentation–Assimilation–Discussion (PAD) model is adopted, combining concise teacher instruction, individual assimilation, and group discussion [8]. Students compare key parameters, waveforms, and spectra. Experimental activities progress from principle verification to parameter analysis and system design, with NI ELVIS II+ used for hardware-based validation [9]. After class, students organize their programs and experimental results and complete reflective summaries and feedback activities.

In parallel with this teaching process, the course adopts a combination of formative and summative assessment. Pre-class preparation, in-class inquiry, post-class assignments and experimental work, and the final examination account for 10%, 30%, 10%, and 50% of the course grade, respectively. Formative assessment focuses on theoretical prediction, model construction, parameter recording, and result analysis, with timely feedback used to reinforce the learning process [10]. Based on students' preparatory work and classroom performance, the instructor adjusts teaching priorities and incorporates programs, parameter records, and experimental explanations into the assessment, thereby aligning assessment with learning activities.

3. Teaching practice

The blended teaching model was implemented in units including analog modulation, sampling, and digital transmission. For each communication problem, a continuous task sequence of "pre-class prediction–in-class verification–experimental inquiry–post-class reflection" was established [11]. Students worked in groups of three to five. They first identified key observation points in the system and predicted the expected changes, and then collaboratively completed LabVIEW programming, parameter adjustment, and result comparison [12]. The instructor used representative cases to organize class discussions and guided students from merely reproducing

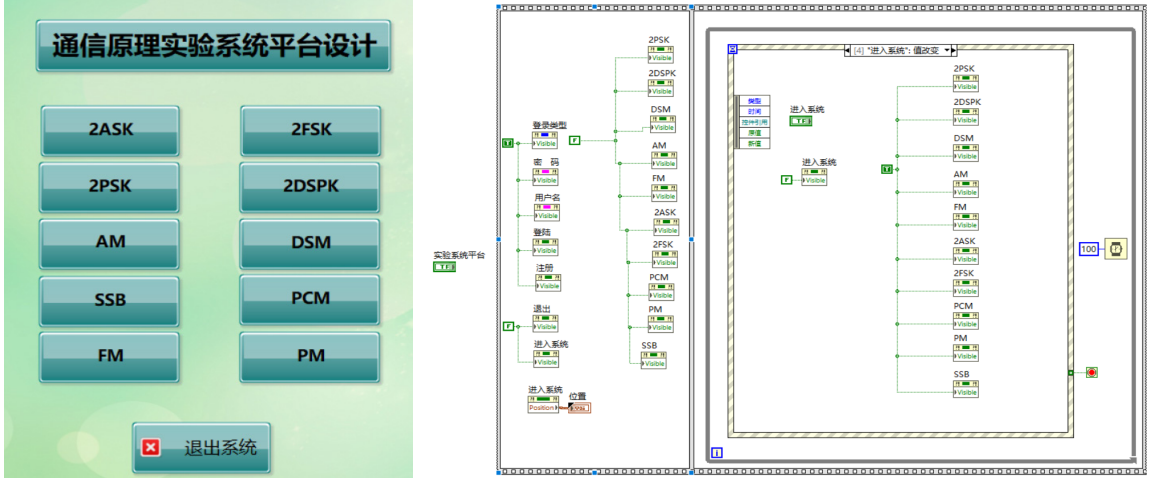
standard waveforms toward analyzing the effects of parameter variations and identifying the causes of abnormal results [13]. In this way, the same concepts were progressively reinforced through theoretical analysis, simulation-based verification, and hardware experiments. Classroom implementation is shown in **Figure 2**.



(a) Group discussion and simulation analysis. (b) Experimental operation and parameter tuning.

Figure 2. Students using LabVIEW for classroom experiments and inquiry.

As experimental tasks progressed from basic verification to parameter analysis and system design, students submitted LabVIEW programs, waveform and spectrum results, parameter-comparison records, and design descriptions. They also analyzed the effects of factors such as signal-to-noise ratio and carrier phase offset on system performance [14]. These student outputs provided evidence of their learning in model construction, parameter analysis, and result interpretation, enabling the instructor to provide more targeted guidance [15]. During implementation, students gradually shifted their attention from simply reproducing standard waveforms to examining parameter variations, error sources, and possible design adjustments, while classroom discussions increasingly focused on causal analysis and comparison of alternative solutions. Selected student LabVIEW projects and simulation results are shown in **Figure 3**.



(a) Front Panel (b) Block Diagram

Figure 3. Examples of student LabVIEW work and simulation results.

4. Conclusion

This study developed a blended teaching model for Communication Principles by integrating Xuexitong, LabVIEW, and NI ELVIS II+. The model organizes theoretical analysis, virtual simulation, and experimental verification around a common set of learning tasks. Teaching practice indicates that this approach can enhance students' understanding of communication systems and foster greater awareness of parameter analysis and system design. Future work will incorporate more systematic teaching data to refine task design and assessment methods further.

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Disclosure statement

The authors declare no conflict of interest.

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