ISSN 2522-6398 Vol. 8, Issue 4: 170-177, DOI: 10.25236/FER.2025.080425

# Teaching Innovation and Practice of Electrical and Electronic Courses Based on Generalized Symmetry

**Qinghong Cao[a,*], Suxia Xie[b]**

*School of Mechanical Engineering, University of Shanghai for Science and Technology, Shanghai, China*
*[a]caoqinghong@usst.edu.cn, [b]xsx@usst.edu.cn*
**Corresponding author*

***Abstract:*** *This paper focuses on the teaching of electrical and electronic courses and deeply explores the teaching improvement methods based on generalized symmetry. It elaborates on the connotation of generalized symmetry and its value in the teaching of this discipline, covering aspects such as knowledge system construction and innovative thinking cultivation. The implementation paths of teaching content reorganization, teaching strategies, and practical teaching based on generalized symmetry are introduced in detail. Through teaching practice, a comparison between classes using the new teaching method and traditional teaching method shows that the teaching method based on generalized symmetry has significant effects in improving the test scores of students, practical abilities, stimulating learning interests, and increasing satisfaction, providing new ideas and empirical evidence for the teaching reform of electrical and electronic courses.*

***Keywords:*** *electrical and electronic courses, generalized symmetry, symmetry thinking, teaching practice*

## 1. Introduction

In the current era of rapid technological development, electrical and electronic courses, as basic disciplines for many engineering majors, their teaching quality is crucial for cultivating high-quality engineering talents. To some extent, traditional teaching methods are difficult to meet the need of students for in-depth knowledge understanding and innovative ability cultivation [1]. As a unique thinking perspective, the generalized symmetry theory has shown important value in multiple disciplinary fields. Introducing it into the teaching of electrical and electronic courses is expected to break through the limitations of traditional teaching and bring new opportunities for teaching reform. This research aims to explore the application of teaching methods based on generalized symmetry in the teaching of electrical and electronic courses. Through theoretical analysis, practical exploration, and effectiveness evaluation, it provides a more effective teaching model for this discipline, helping to cultivate innovative engineering talents who meet the needs of the times.

## 2. The Connotation of Generalized Symmetry and Its Value-empowering in the Teaching of Electrical and Electronic Courses

### *2.1. The Connotation of Generalized Symmetry*

Generalized symmetry refers to the existence of various forms of symmetrical relationships in different disciplinary fields and different systems. It is rich and diverse, not limited to geometric symmetry. Instead, it comprehensively covers many levels, such as structural symmetry, functional symmetry, mathematical model symmetry, and physical law symmetry. These symmetrical relationships not only reflect the harmony and unity of things but also the internal laws and close connections of their development [2].

For example, Newton's laws of motion maintain symmetry in different inertial reference frames. No matter what uniform linear motion state the observer is in, the form of Newton's laws of motion remains constant, which lays a solid foundation for the wide application of classical mechanics. The symmetry of Maxwell's equations under space-time transformation is even more exquisite. It perfectly reveals the interdependence and transformation relationship between the electric field and the magnetic field, demonstrating the harmony and unity of all things in the universe at the electromagnetic level. Focusing

ISSN 2522-6398 Vol. 8, Issue 4: 170-177, DOI: 10.25236/FER.2025.080425

on the field of electrical and electronic courses, generalized symmetry is subtly integrated into key links such as circuit structure, signal characteristics, and electromagnetic relationships.

### *2.2. The Connotation of Generalized Symmetry and Its Value-Empowering in the Teaching of Electrical and Electronic Courses*

Symmetrical thinking, a way of thinking derived from the concept of generalized symmetry, simplifies, analyzes, and solves problems by finding and using the symmetry of things from a unique perspective. In electrical and electronic courses, symmetrical thinking has a wide range of applications. For example, when analyzing complex circuits, the symmetry of the circuit can be used to decompose it into several symmetrical subcircuits, which are analyzed and calculated separately, and then the characteristics of the entire circuit are obtained through synthesis. When designing electronic systems, applying the principle of symmetry in circuit layout and component selection can greatly improve the stability and reliability of the system, effectively reducing the risk of mistakes in the design process and unnecessary cost investment.

In addition, symmetrical thinking can also help students understand the complex physical phenomena and laws in circuits from a new perspective, stimulate the curiosity and exploration desire of students, and cultivate the innovative thinking ability of them. When facing circuit problems, students can break the routine and come up with creative solutions.

### *2.3. The Value-Empowering of Generalized Symmetry in the Teaching of Electrical and Electronic Courses*

#### *2.3.1. Helping Students Build a Solid Knowledge System*

In the knowledge field of electrical and electronic courses, many concepts, theorems, and principles seem chaotic and disorderly, but in fact, there are close generalized symmetrical relationships.

For example, in the basic circuit part, there are symmetrical aspects in the basic analysis methods of DC circuits and AC circuits. Both follow basic laws such as Ohm’s law and Kirchhoff’s laws [3], but there are differences in the characteristics of voltage and current, power calculation methods, etc. By deeply analyzing these symmetries and differences, students no longer view each knowledge module in isolation but can integrate them in a more systematic way. Taking the three basic components of resistors, capacitors, and inductors as an example, their functions and characteristics have significant differences but also have generalized symmetrical relationships. Resistors impede current according to Ohm’s law; capacitors exhibit capacitive reactance characteristics in AC circuits, and their current-voltage phase relationship is completely different from that of resistors. However, in terms of energy storage and release in the circuit, they have similar symmetrical manifestations to inductors. Once students master these generalized symmetrical relationships, they can connect scattered knowledge points such as circuit components and circuit analysis methods, just like building a building, gradually constructing a complete knowledge system from the foundation. This systematic learning method not only strengthens knowledge memorization, but more importantly, enables students to understand the intrinsic connections between knowledge. When facing complex circuit problems, they can quickly call on relevant knowledge for analysis and solution, greatly improving learning efficiency.

#### *2.3.2. Enlightening the Wisdom of Innovative Thinking*

The unique way of thinking contained in generalized symmetry opens a new door of thinking for students. Under the traditional teaching mode, students are used to thinking in a fixed mode and way. Generalized symmetry encourages them to break through the routine and examine various phenomena and problems in electrical and electronic courses from multiple perspectives.

For example, in the learning process of digital circuits, the design and analysis of logic gate circuits usually follow conventional methods. However, from the perspective of generalized symmetry, if students consider the dual relationship between different logic gates, such as the symmetry in the logic functions of AND gates and OR gates, they may develop new circuit design ideas. In actual teaching cases, by guiding students to analyze the same circuit problem from the positive and negative sides of symmetry, such as analyzing the forward amplification characteristics of an amplifier circuit and then exploring the problems and characteristics of reverse signal transmission, students can not only comprehensively understand the circuit principle but also have their innovative thinking fully stimulated. In the electronic circuit design course, when students are required to design a circuit module with specific functions using the principle of generalized symmetry, they explore the symmetrical relationships in

ISSN 2522-6398 Vol. 8, Issue 4: 170-177, DOI: 10.25236/FER.2025.080425

circuit structure, signal processing methods, etc., and put forward many ingenious design schemes, showing their innovative abilities. The cultivation of this innovative thinking is not only beneficial to students to learn in the field of electrical and electronic courses but also provides a unique and effective solution for them to overcome complex problems in future engineering practices and scientific research, becoming a powerful weapon for them to explore unknown fields.

#### *2.3.3. Comprehensively Improving Practical Abilities of students*

Practical teaching is a crucial link in the teaching of electrical and electronic courses, and the principle of generalized symmetry plays an important role in it. In the experimental design stage, experiments with both comparability and inspiration can be designed with the help of the principle of generalized symmetry. For example, design an experiment to compare the characteristics of series-resonant circuits and parallel-resonant circuits. These two types of circuits show distinct symmetry in structure: one is a series connection of an inductor and a capacitor, and the other is a parallel connection. Students can directly observe the symmetries and differences in their characteristics by measuring parameters such as current, voltage, and impedance of the two circuits at different frequencies, thus deeply understanding the working principle of resonant circuits.

During the experiment, failures are inevitable. Using symmetrical thinking for fault analysis can help students quickly locate the problem. When the output of a complex electronic circuit is abnormal, students start from the symmetrical structure of the circuit, compare the normal and abnormal parts, and analyze whether the change of component parameters has broken the original symmetrical relationship, thereby finding the cause of the fault. Through such practical training, practical operation abilities of students are significantly enhanced. They can use experimental instruments more skillfully, accurately build circuits, and measure parameters. At the same time, their problem-solving abilities are fully exercised. In the face of circuit failures in actual engineering in the future, they can quickly analyze and solve them using generalized symmetrical thinking, becoming professional talents with both theoretical and practical abilities.

#### *2.3.4. Adding Interest and Vitality to Teaching Content*

The teaching content of traditional electrical and electronic courses is often considered boring by students because of its strong theoretical nature and high degree of abstraction. The perspective of generalized symmetry injects new vitality into the teaching content, making it vivid and interesting. Taking the electromagnetic induction phenomenon as an example, conventional teaching may only explain the basic principles and formulas. However, from the perspective of generalized symmetry, by introducing the symmetrical phenomena of magnetic-induced electricity and current-induced magnetism and comparing their generation conditions and mutual relationships, students can appreciate the wonderful symmetry in nature.

With the help of multimedia teaching means, the symmetrical changes of circuit structures and signal waveforms, such as the symmetry of the positive and negative half-cycle of sinusoidal alternating current and the symmetry of high and low levels of digital signals, are displayed, allowing students to visually feel the unique charm of generalized symmetry from a visual perspective. The interesting teaching content stimulates learning interests of students, prompting them to change from passive knowledge receivers to active knowledge explorers and actively participate in classroom discussions and practical activities. As learning initiative of students increases, the classroom atmosphere becomes more active, and the teaching quality and effect are significantly improved, laying a solid foundation for students to deeply learn the knowledge of electrical and electronic courses and enabling them to continuously explore on the interesting journey of knowledge.

## 3. Exploration of the Path to Implement the Teaching of Electrical and Electronic Courses Based on Generalized Symmetry

### *3.1. Reorganization of Teaching Content Based on Generalized Symmetry*

#### *3.1.1. Deeply Exploring the Symmetrical Relationships of Knowledge*

In traditional teaching of electrical and electronic courses, the knowledge of electrical and electronic parts is like two isolated islands, making it difficult for students to understand their internal connections. To completely break this teaching dilemma, teachers take generalized symmetry as the core clue and deeply reintegrate and carefully arrange the teaching content.

For example, when introducing electronic devices, diodes, transistors, and field-effect transistors, as the core “members” of the electronic field, their working principles and characteristics are unique, but there are wonderful generalized symmetrical relationships [4]. A diode is like a one-way “traffic policeman” that only allows current to flow in one direction and is mainly active in circuits such as rectification and clipping, ensuring the normal operation of the circuit. A transistor is like a flexible “current commander” that can skillfully control the current between the collector and the emitter through the base current, achieving a powerful current amplification function and contributing to signal enhancement. A field-effect transistor is like an elegant “voltage control master” that precisely controls the current between the drain and the source using the gate voltage, with unique advantages such as high input resistance and low noise, playing an important role in high-end electronic devices. By comparison, it is found that both transistors and field-effect transistors can be used for signal amplification, but the control methods are different, which reflects their symmetries and differences in circuit applications. As shown in Figure 1 - 3, several symmetry examples are explored in electrical and electronics courses.

| | | |
|---|---|---|
| **Symmetry Principles in Circuit Analysis** | Form Symmetry of Ohm's Law | DC circuit：U=I*R (R: Resistance) |
| | | AC cuircuit: u=i*Z (Z: Complex impedance) |
| | Conservation Symmetry of Kirchhoff's Laws | KCL: ΣI = 0 ⟶ Charge conservation |
| | | KVL: ΣU = 0 ⟶ Energy conservation |
| | Linear Symmetry of the Superposition Principle | Reflecting the invariance of the system’s linear response to excitations in linear circuits. |
| | Topological Symmetry of Thévenin-Norton Equivalence | Voltage source and resistor in serie; Current source and resistor in parallel. |

*Figure 1: Exploring Symmetry Principles in Circuit Analysis.*

| | | |
|---|---|---|
| **Symmetry Applications in Electronic Circuit Design** | Structural Symmetry of Differential Amplifier Circuits | Demonstrating the correlation between geometric symmetry and functional stability. |
| | Input Symmetry of Digital Logic Gates | The symmetric arrangement of input terminals in logic devices such as XOR and XNOR. |
| | Topological Symmetry of Bridge Circuits | Symmetrical arrangement of switching devices in full bridge/half bridge rectifier circuit. |

*Figure 2: Exploring Symmetry Applications in Electronic Circuit Design.*

| | | |
|---|---|---|
| **Symmetry in Power Systems and Electromagnetic Theory** | Balanced Symmetry of Three-Phase Systems | Under symmetric three-phase loads, voltages and currents exhibit equal amplitudes and 120° phase differences, simplifying system analysis and calculation. |
| | Spatiotemporal Symmetry of Electromagnetic Field Equations | The symmetry of Maxwell’s equations under time-reversal and space-mirror transformations forms is the basis for understanding electromagnetic field propagation laws. |
| | Analogical Symmetry Between Magnetic and Electric Circuits | The mathematical symmetry between magnetic reluctance/magnetomotive force and electrical resistance/voltage supports a unified analytical approach for magnetic and electric circuits. |

*Figure 3: Exploring Symmetries in Power Systems and Electromagnetic Theory.*

Through such in-depth comparative analysis, students can clearly understand the internal connections between different knowledge modules, thus constructing a systematic and complete knowledge system. When facing complex circuit problems, students can draw inferences from one another based on these symmetrical relationships, flexibly use the learned knowledge, and find the key to solving the problems, better mastering the circuit analysis method.

#### *3.1.2. Skilfully Integrating Emerging Technology Content*

In the rapidly development era of science and technology, cutting-edge emerging technologies and applications continue to emerge in the field of electrical and electronic courses. To make the teaching content meet the needs of the times and cultivate high-quality talents who can adapt to industry changes, teachers must maintain a keen sense of insight in the teaching process, pay close attention to the latest development trends in the field of electrical and electronic technology, and actively and skillfully integrate emerging technology content into the daily teaching system. More importantly, it is necessary

ISSN 2522-6398 Vol. 8, Issue 4: 170-177, DOI: 10.25236/FER.2025.080425

to deeply analyze the intricate connections between these emerging technologies and traditional knowledge from the perspective of generalized symmetry, allowing students to broaden their horizons and enhance their abilities in the collision and integration of new and old knowledge.

Taking the new energy power generation field as an example, new energy power generation technologies such as solar photovoltaic power generation and wind power generation are developing rapidly. When integrating these emerging technologies into teaching, teachers can establish connections with traditional knowledge from multiple dimensions. When explaining the solar photovoltaic power generation system, from the perspective of generalized symmetry, it has certain similarities and symmetries with the traditional DC power supply system. The traditional DC power supply system is committed to converting other forms of energy into stable DC electrical energy output, while the solar photovoltaic power generation system directly converts solar energy into DC electrical energy through photovoltaic cells. Both have consistency in the form of electrical energy output, both output DC power, and both need to consider issues such as electrical energy storage, conversion, and transmission. In terms of wind power generation technology, the working principle of its core component, the wind turbine, has a generalized symmetrical relationship with the traditional motor principle. The traditional motor realizes the mutual conversion of electrical energy and mechanical energy through the force of a current-carrying conductor in a magnetic field based on Faraday's law of electromagnetic induction. The wind turbine uses the wind to drive the rotation of the wind wheel, and then drives the rotation of the rotor of the generator, cutting the magnetic induction lines in the magnetic field to generate an induced electromotive force, realizing the conversion of mechanical energy into electrical energy. From the perspective of energy conversion, the two have the same effect, both realizing the transformation of energy forms based on electromagnetic induction. However, due to the complex and changeable working environment of wind turbines, they need to have stronger wind-resistance capabilities, intelligent adjustment mechanisms to adapt to different wind speeds, and other special features, which makes them different from traditional motors in specific structures and operating characteristics. In the teaching process, guiding students to deeply explore these similarities and differences can not only enable students to better understand the emerging wind power generation technology but also deepen their understanding of the traditional motor principle, thus constructing a more comprehensive and in-depth knowledge system.

### *3.2. Teaching Strategies Based on Generalized Symmetry*

#### *3.2.1. Problem-Oriented Teaching: The Engine to Stimulate Thinking*

Problem-oriented teaching takes the symmetrical relationships of knowledge as the starting point, carefully designs a series of inspiring questions, and guides students to think actively and explore deeply.

When teaching the combinational logic circuits and sequential logic circuits in digital circuits, teachers ask the question, "What are the symmetries and differences in functions and structures between combinational logic circuits and sequential logic circuits?" The output of a combinational logic circuit only depends on the current input, such as common encoders and decoders; while the output of a sequential logic circuit depends not only on the current input but also on the past state of the circuit, such as counters and registers. Students conduct in-depth analysis of the symmetries and differences between the two in terms of logic expressions, state transition diagrams, and hardware implementations by referring to professional books, academic papers, and carrying out group discussions. In this process, students are no longer passive knowledge recipients but active explorers. Their self-learning abilities are greatly exercised, the breadth and depth of their thinking are expanded, and they gradually learn to think about problems from different angles and improve their abilities to solve complex problems.

#### *3.2.2. Analogical Teaching Method: The Bridge of Knowledge Transfer*

By means of the principle of generalized symmetry, the analogy teaching method closely connects new knowledge with the relevant knowledge that students have already learned, just like building a bridge between new and old knowledge to help students better understand the new knowledge.

When teaching transformers, by comparing the working principle of transformers with the mutual inductance phenomenon of inductors, it can be found that a transformer is actually made based on the mutual inductance principle. It has two unique "partners", the primary winding and the secondary winding. By reasonably designing the turns ratio of the windings, it realizes the magical transformation of voltage, like a magical "voltage magician". This analogy makes the originally abstract and obscure working principle of transformers vivid and easy to understand. Students can quickly master the core principle of transformers with the help of the familiar knowledge of inductor mutual inductance. At the same time, this also deepens the understanding of the basic theory of electromagnetic induction, like

ISSN 2522-6398 Vol. 8, Issue 4: 170-177, DOI: 10.25236/FER.2025.080425

strengthening another layer on the foundation of knowledge, and improves the ability of knowledge transfer.

#### *3.2.3. Cultivating Symmetrical Thinking: The Key to Open Wisdom*

Pay attention to guiding students to use symmetrical thinking to analyze and solve problems. When teaching circuit analysis methods, teachers guide students to simplify the circuit analysis process using methods such as the superposition theorem and Thevenin's theorem by analyzing the symmetry of the circuit, making complex circuit problems clear. When teaching electronic circuits, encourage students to think about the design and optimization of circuits from a symmetrical perspective. For example, think about how to improve the performance of an amplifier through a symmetrical circuit structure. At the same time, set symmetrical problems and cases for students to conduct group discussions and analyses. In the collision of thinking, cultivate the teamwork spirit and symmetrical thinking ability of students, so that they can learn to cooperate with each other and make progress together in the process of solving problems.

#### *3.2.4. Adopting Diversified Teaching Means: Enhancing Teaching Effects*

Combined with diversified teaching means such as multimedia teaching, virtual simulation experiments, and online teaching platforms, enrich the teaching content and teaching forms. Use multimedia teaching tools to display the symmetrical structures, circuit dynamic processes, and experimental phenomena in electrical and electronic technology, making abstract knowledge more intuitive and vivid. With the help of virtual simulation experiment software, students can conduct circuit design, analysis, and experimental operations in a virtual environment without being restricted by time and space, improving learning efficiency and learning interest of students. Use the online teaching platform to carry out online discussions, question-answering, homework submission, and grading activities, strengthening the interaction and communication between teachers and students. Teachers can timely understand the learning situations and problems of students and provide more targeted guidance for them.

### *3.3. Practical Teaching Based on Generalized Symmetry*

#### *3.3.1. Experimental Content Design: A Practical Journey to Explore Knowledge*

In the experimental teaching link, in order to give full play to the role of generalized symmetry in teaching, carefully conceive and design experimental content with symmetrical relationships [5]. Take the comparative experiment on the characteristics of series-resonant circuits and parallel-resonant circuits as an example. These two types of circuits show obvious symmetrical forms in structure. The series-resonant circuit is composed of a resistor, an inductor, and a capacitor connected in series, while the parallel-resonant circuit is a parallel connection of a resistor, an inductor, and a capacitor. During the experiment, students are provided with AC power supplies of different frequencies, and they are required to carefully observe the changes in current and voltage of the circuits under different resonance conditions. When the series-resonant circuit reaches the resonance state, its impedance is the smallest, the current reaches the maximum value, and the inductor voltage and capacitor voltage are equal in magnitude and opposite in phase. When the parallel-resonant circuit is in resonance, its impedance is the largest, the current is the smallest, and the inductor current and capacitor current are equal in magnitude and opposite in phase. Through hands-on operation and data recording, students can deeply analyze their symmetrical relationships in terms of resonance frequency, impedance characteristics, energy conversion, etc., and then explore their roles in different application scenarios such as radio communication and power systems. For example, series resonance is often used for signal frequency selection to allow specific-frequency signals to pass smoothly, while parallel resonance can be used to improve the power factor of power systems.

In this way, students not only master the basic characteristics of resonant circuits but also learn how to select the appropriate circuit structure according to actual needs, truly applying theoretical knowledge to practice and converting it into practical abilities.

#### *3.3.2. Experimental Fault Diagnosis: The Sharpening of Problem-Solving Thinking*

When an experiment fails, teachers guide students to use the thinking method of generalized symmetry for fault diagnosis, starting from the symmetrical relationships of circuit structures and component parameters. In the amplifier circuit experiment, if the output signal is distorted, since the amplifier circuit has a certain symmetrical structure, the bias circuit of the transistor determines the operating state of the transistor, and the signal input-output loop is responsible for signal transmission

ISSN 2522-6398 Vol. 8, Issue 4: 170-177, DOI: 10.25236/FER.2025.080425

and amplification. From a symmetrical perspective, changes in the parameters of each component in the bias circuit will affect the static operating point of the transistor, and then affect the signal amplification effect. The symmetry of the signal input-output loop also affects the integrity of the signal. Students can follow this symmetrical relationship to check one by one whether the bias resistors have changed in value, whether the capacitors are leaking, and whether the input-output coupling capacitors are normal, gradually narrowing down the scope of the fault and locating the fault point.

Through such fault diagnosis training, students gradually master the method of using generalized symmetrical thinking to solve practical problems. This not only improves their fault diagnosis ability but also exercises their practical operation ability and logical thinking ability, laying a solid foundation for their future work in actual engineering.

#### *3.3.3. Practical Project Design: The Stage for Integrating Theory and Practice*

Design practical teaching projects based on generalized symmetry to organically combine theoretical knowledge and practical operations. For example, offer an experiment on symmetrical three-phase circuits, allowing students to measure the phase voltage and current in the experiment, observe the operating states of the circuit under symmetrical and asymmetrical conditions, and analyze the impact of asymmetrical factors on the circuit performance. Carry out electronic circuit design experiments, requiring students to design electronic circuits with specific functions using the principle of symmetry, such as the power amplifiers and filters with symmetrical structure, and then build and debug the circuits. In this process, students need to convert the learned theoretical knowledge into actual circuit designs, constantly try and optimize, so as to improve their practical operation ability and innovation ability.

#### *3.3.4. Actual Engineering Project Design: The Journey to Improve Comprehensive Quality*

Based on actual engineering projects, implement the project-based learning teaching method. Divide students into several project groups, and each group is responsible for the design, implementation, and debugging of a project.

For example, given a design project of a smart home control system, students are required to use electrical and electronic technology knowledge to design the hardware circuit and software program of the system to achieve intelligent control of home devices. During the project implementation process, students need to comprehensively apply knowledge and skills in many aspects, such as circuit analysis, electronic device application, signal processing, and microcontroller programming, to solve various problems encountered in the project. Through project-based learning, the engineering practice ability, the teamwork ability, and the innovation ability of students are exercised, promoting the comprehensive application of the knowledge and improving the comprehensive quality of students, so that they can calmly face various challenges in their future careers.

## 4. Evaluation of Teaching Practice Results

In the continuous exploration process of the education field, in order to accurately verify the unique educational effectiveness of the teaching method based on the generalized symmetry theory, the electrical engineering research team carried out rigorous teaching practice. Through distributing questionnaires to students majoring in multiple engineering fields, a teaching reform experimental class was formed on a basis of voluntary-participation. At the same time, a class taught by the traditional teaching method was selected as a control group. The teaching effectiveness was deeply analyzed from multiple dimensions, such as knowledge acquisition, skill improvement, thinking expansion, and learning interest, using a combination of quantitative and qualitative analysis methods. The aim is to comprehensively, systematically, and accurately reveal the advantages of this innovative teaching model and provide empirical evidence with reference value for education and teaching reform.

### *4.1. In-Depth Analysis of Test Scores*

The research team conducted a rigorous and meticulous statistical analysis of the final-exam scores of the two classes. The data clearly and intuitively shows that the average score of the class taught by the teaching method based on generalized symmetry increased by about 10 points compared with that of the traditional-teaching class. In terms of the excellent rate (90 points and above), the excellent rate of this class increased by 20%; the pass rate also increased significantly by 15%. These quantitative data strongly reflect that the teaching method based on generalized symmetry is like a key to opening the door of knowledge, which can help students more efficiently master the knowledge system, achieve a

ISSN 2522-6398 Vol. 8, Issue 4: 170-177, DOI: 10.25236/FER.2025.080425

qualitative breakthrough and improvement in academic performance, and truly demonstrate its strong promoting role in knowledge imparting and ability cultivation.

### *4.2. Comprehensive Evaluation of Practical Abilities*

When focusing on and deeply evaluating the performances of students in key practical links such as experimental operations and course designs, the significant advantages of the teaching method based on generalized symmetry were fully demonstrated. The students in this class were skillful and precise in practical operations. In terms of experimental fault diagnosis ability, they could quickly identify the root cause of problems with keen insights. Their innovative design abilities also surpassed those of students in the traditional teaching class in all aspects. Taking the project for the circuit design as an example, students in the class taught by the teaching method based on generalized symmetry could flexibly and skillfully use the learned knowledge to construct ingenious and innovative circuit schemes. And during the complex and cumbersome process of circuit debugging, they could quickly and accurately locate and solve various problems, fully demonstrating excellent practical qualities and flexible response abilities.

### *4.3. Survey of Learning Attitude and Satisfaction*

Through a carefully designed questionnaire survey, the research team deeply explored the learning attitudes and satisfaction of students with the teaching method. The survey results show that the students in the class taught by the teaching method based on generalized symmetry had a significant increase in their interest in the course. They generally reported that the course content was no longer a boring pile of theories but a treasure trove of knowledge full of interest and practical value. Their satisfaction with the teaching method was as high as 95%. In contrast, students in the traditional teaching class had relatively low learning interests and satisfaction and did not show strong learning enthusiasm and positive attitudes.

## 5. Conclusions

This research systematically integrates the generalized symmetry theory into the teaching of electrical and electronic courses, and conducts comprehensive exploration from theoretical explanation to teaching practice. By deeply exploring the symmetrical relationships of knowledge, integrating emerging technologies, the teaching content has been optimized. By using teaching strategies such as problem-oriented teaching and analogy teaching methods, the teaching methods have been improved. With the help of carefully designed practical teaching links, the practical abilities of students have been enhanced. The evaluation of teaching practice results shows that the teaching method based on generalized symmetry has significantly improved the knowledge acquisition, practical skills, learning interests, and satisfaction of students. However, teaching reform is a continuous process. In the future, it is possible to further expand the depth and breadth of the application of generalized symmetry in teaching, explore its integration with more cutting-edge technologies, and continuously optimize teaching strategies to adapt to the changing educational needs and industry development. This will inject lasting impetus into the teaching reform of electrical and electronic courses and cultivate more professionals with innovative spirits and practical abilities.

## References

*[1] Cao Qinghong, Xie Suxia. Practical Exploration of Teaching Method Reform in Electrical and Electronic Technology [J]. Education Progress, 2024, (7): 175 - 179.*

*[2] Wu Hongyi. The Principle of Generalized Symmetry [J]. Guangdong Science & Technology, 2010, 19(16): 23 - 26.*

*[3] Wang Yusong. Kirchhoff's Laws and Circuits [J]. Technology Wind, 2017(2): 138.*

*[4] Xie Suxia, Xie Ming, Yi Yingping, Tu Jiancheng. Exploration and Practice of Ideological and Political Education in the Course of Electrical and Electronic Science [J]. Education Progress, 2022, 12(7): 2597 - 2601.*

*[5] Liu Fenfen. Exploration of Professional Modular Teaching in College Physics Experiment Courses [J]. Education Teaching Forum, 2019(43): 170 - 171.*