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| Research Article

# Improving the Methodology for Developing Practical Diagnostic Skills among Students Specializing in Technical Fields

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**Abstract:** The ability to accurately diagnose technical issues is a fundamental skill for students in technical disciplines. Despite existing training methods, there remains a gap in effectively fostering practical diagnostic competencies. This study examines current approaches, proposes an improved methodology, and evaluates its effectiveness. Results indicate that an integrated, case-based, and hands-on training program significantly enhances students' diagnostic skills. This research contributes to optimizing educational strategies in technical education, promoting more competent future professionals.

**Keywords:** Case-Based Learning, Hands-On Practice, Collaborative Problem Solving, Progressive Complexity.



## Introduction

In technical fields such as electronics, mechanical engineering, and information technology, diagnostic skills are vital for troubleshooting and maintaining complex systems. Traditionally, students acquire these skills through theoretical coursework supplemented by limited practical exercises. However, the complexity of modern systems necessitates more effective training approaches to develop nuanced diagnostic abilities. Existing methodologies often lack a structured, experiential platform that simulates real-world scenarios. The purpose of this study is to improve the methodology for developing practical diagnostic skills among technical students, thereby addressing the current educational gaps and enhancing their readiness for professional challenges.

## Methods

A quasi-experimental design was employed involving two groups of third-year technical students: a control group (n=30) undergoing traditional training and an experimental group (n=30) experiencing an enhanced, integrated diagnostic methodology. The improved methodology incorporated the following components:

**1. Case-Based Learning: Students analyzed real-world fault scenarios.**

This methodology has 4 main key features:

- Authentic Situations: Students work with real or realistically simulated fault cases, which include detailed data, technical reports, sensor readings, historical records, images, and operational logs.
- Active Problem Solving: Rather than passively listening to lectures, students collaboratively analyze, diagnose, and develop solutions based on the information provided.
- Interdisciplinary Approach: Fault scenarios often require knowledge spanning multiple technical domains such as electrical systems, mechanical components, control systems, and safety protocols.
- Reflective Analysis: After exploring the case, students reflect on the causes, consequences, and potential preventative measures, fostering deeper understanding.

Case-based learning has lots of benefits. This methodology enhances practical understanding of complex systems and develops critical thinking, diagnostic reasoning, and decision-making skills. Case-based learning also helps to bridge the gap between theoretical knowledge and real-world application. One of the advantages of it to prepare students for industry challenges by exposing them to common faults and troubleshooting technique

**2. Hands-On Practice: Use of simulated and actual diagnostic tools**.

Simulation-based training complements hands-on practice by offering:

- Risk-Free Learning Environment: Students can experiment and make mistakes without risking equipment or safety.
- Cost-Effectiveness: Simulators reduce wear and tear on expensive equipment.
- Scenario-Based Training: Simulations can replicate varied operational conditions and emergency situations that might be difficult or unsafe to recreate in real life.
- Progressive Skill Development: Students can start with simulations to build foundational skills before progressing to actual tools.

**3. Collaborative Problem Solving: Group exercises to foster teamwork.**

This method involves group exercises where students work together to solve real-world technical problems. It encourages teamwork, communication, and critical thinking. Students share ideas, divide tasks according to strengths, and learn from each other. This hands-on approach helps develop practical skills and prepares students for collaborative work environments in their careers

**4. Progressive Complexity: Gradually increasing difficulty of diagnostic tasks.**

This method involves starting with simple diagnostic tasks and gradually increasing their difficulty. It helps students build foundational knowledge step-by-step, boosting their confidence. As challenges become more complex, students develop deeper understanding and problem-solving skills, preparing them for real-world technical problems.

The intervention lasted one semester (16 weeks). Diagnostic proficiency was assessed pre- and post-intervention using a standardized diagnostic test comprising practical tasks, theoretical questions, and time-to-diagnose metrics. Data were analyzed statistically to compare improvements between groups.

## Results

Pre-intervention assessments showed no significant differences in diagnostic skills between the control and experimental groups ($p>0.05$). Post-intervention, the experimental group demonstrated a statistically significant improvement in diagnostic accuracy (mean score increase of 25 points, $p<0.01$) and reduction in diagnosis time (average decrease of 15 minutes, $p<0.05$). The control group showed modest improvements, which were not statistically significant. Additionally, qualitative feedback indicated higher student engagement and confidence in diagnostic tasks within the experimental group.

## Discussion

The findings suggest that integrating case-based problems, hands-on practice, and collaborative learning substantially enhances practical diagnostic skills. The improved methodology addresses limitations of traditional approaches by providing realistic and challenging scenarios, fostering critical thinking, and promoting active learning. It aligns with pedagogical theories emphasizing contextual learning and experiential education. Limitations include the relatively short duration and specific focus on electronics diagnosis; thus, further research is needed to generalize findings across different fields and extended periods.

## Conclusion

An evolved educational methodology that combines case-based learning, hands-on experience, and collaborative problem-solving effectively enhances diagnostic competencies among technical students. Implementing such integrated approaches can bridge the gap between theoretical knowledge and practical skills, better preparing students for professional troubleshooting tasks. Future studies should explore long-term retention of skills and adaptation across various disciplines to further optimize technical education.

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