

EVALUATING TROUBLESHOOTING SKILLS OF ELECTRONICS TECHNOLOGY STUDENTS FOR INDUSTRY RELEVANCE

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ABSTRACT. *This study evaluates the troubleshooting skills of Electronics Technology students at Zamboanga Peninsula Polytechnic State University in Western Mindanao, Philippines, concerning industry demands. The research specifically examines the student's knowledge and application of various tools and equipment, diagnostic skills, and systematic troubleshooting procedures for electronically controlled domestic appliances. A descriptive research design was utilized, with a self-administered survey conducted among 61 graduating students from different electronics programs at the university. The results indicated that students are "very knowledgeable" in using digital and analogue multitaskers, with a mean score of 3.82. This proficiency is crucial as multitaskers are fundamental for measuring voltage, resistance, and current, which are essential in diagnosing and troubleshooting electronic circuits. Conversely, students showed lower proficiency with oscilloscopes, which had the lowest mean score of 1.88. Oscilloscopes are vital for observing voltage waveforms and analyzing properties such as amplitude and frequency, essential for advanced troubleshooting and diagnostics. This gap in handling advanced diagnostic tools points to a critical area for curriculum enhancement. In terms of fundamental troubleshooting procedures, students exhibited "average skills" in conducting resistance measurements ($M = 2.87$) and ensuring systematic power supply regulation before powering up ($M = 2.85$). These skills are necessary for identifying various faults, such as short circuits and faulty components, and ensuring the stability of the power supply after repairs. However, skills in circuit tracing ($M = 2.65$) and adherence to systematic post-testing protocols ($M = 2.64$) were less developed. Circuit tracing is essential for identifying loose contacts and broken circuits, while systematic post-testing ensures comprehensive and consistent repairs. The overall grand mean scores of 2.72 for tool knowledge and 2.78 for systematic procedures suggest that while students possess a reasonable level of competency, there is a need for further training to meet industry standards more effectively. The study highlights the need for curriculum enhancements, including incorporating advanced diagnostic tools and comprehensive troubleshooting techniques to better prepare students for professional demands. Additionally, targeted training programs and partnerships with industry professionals are recommended to provide students with practical, real-world experience. These improvements will help bridge the gap between academic preparation and industry expectations, ensuring that graduates are equipped with the necessary skills for effective troubleshooting in their careers.*

Keywords: Curriculum Development, Diagnostic Tools, Electronics Technology, Industry Standards, Troubleshooting Skills

1. INTRODUCTION

In contemporary society, electronically controlled domestic appliances are indispensable, facilitating a wide range of household tasks such as cleaning, washing, drying clothes, and regulating indoor climate [1]. Electronically controlled appliances offer unparalleled convenience. For instance, smart ovens can be preheated remotely via smartphone apps, while washing machines can be programmed to operate during off-peak electricity hours to save costs [2]. Their primary function is to simplify daily routines, thereby reducing stress and enhancing quality of life.

Despite their benefits, these appliances are prone to various mechanical and electrical issues over time. Common mechanical problems include dirt accumulation lack of lubrication [3], deteriorated rubber parts, and broken gears [4]. Electrical faults often involve broken connections, short circuits, and overheated components [5]. The cost of repairing or replacing these appliances can be significant, underscoring the need for proficient troubleshooting skills among technicians [6].

Effective troubleshooting is essential for both novice and experienced electronics technicians. Initial attempts to repair electronic circuits often fail, especially for beginners. It can be daunting when components exhibit unexpected behavior or malfunction entirely. Troubleshooting requires identifying common problems quickly and applying diagnostic techniques systematically to resolve issues efficiently. This approach not only ensures high-quality repairs but also extends the lifespan of appliances [7, 8]

One effective technique is step-by-step troubleshooting, where the circuit is divided into sections to identify defects systematically [9]. This method allows technicians to isolate and fix issues more efficiently. Mastery of such techniques is crucial for achieving industry-standard troubleshooting proficiency.

Zamboanga Peninsula Polytechnic State University (ZPPSU) has been offering electronics courses for over a decade, aiming to produce globally competitive graduates equipped with technical skills. Despite its efforts, ZPPSU graduates often face challenges in troubleshooting electronically controlled domestic appliances, indicating a gap between academic training and industry requirements.

The industry relies heavily on graduates from Technical and Vocational Education and Training (TVET) programs to meet its need for skilled technicians. Therefore, the skills acquired by students must align with industry standards [10]. Hence, enhanced troubleshooting and problem-solving skills are necessary not only for understanding machine operations but also for improving technological literacy and repair processes.

With rapid technological advancements, educational institutions must continuously update their curricula to remain relevant to industry standards. This alignment provides students with a robust platform to develop real-world skills, enhance their technical abilities, and produce globally competent professionals. At ZPPSU, it is crucial to evaluate and revise the Electronics Technology curriculum to

better equip students with the troubleshooting skills demanded by the industry [2].

This study aims to assess the relevance of the troubleshooting skills acquired by students enrolled in the Electronics Technology curriculum at ZPPSU to current industry demands. Specifically, it seeks to address the following question: What are the essential skills of Electronics Technology students for troubleshooting basic industrial and household appliances in terms of:

- Identifying the uses of different types of tools?
- Testing instruments for maintaining and repairing electronically controlled domestic appliances?
- Applying symptoms diagnosis and systematic pre-testing procedures?

2. SIGNIFICANCE OF THE STUDY

The findings of this study will benefit several stakeholders by providing valuable insights and practical applications. For the College Administration, the results will serve as a baseline for curriculum revision, ensuring alignment with industry needs and enhancing graduate employability. Electronic Instructors will gain insights to refine and improve their teaching methods, particularly in teaching electronics repair. Electronics Technicians will benefit from practical troubleshooting aids, improving fault-finding procedures, especially in the use of tools and equipment during the pre-testing and post-testing stages. Lastly, the study will guide future researchers by offering new insights and information for further investigations into developing quality instructional methods in electronic technology.

3. SCOPE AND DELIMITATION OF THE STUDY

This study focuses on evaluating the perceived level of knowledge and skills in basic troubleshooting among graduating students in the Electronics Technology program at ZPPSU. The scope is limited to troubleshooting skills related to repairing domestically controlled electronic appliances, specifically the use of various testing instruments, symptom diagnosis, systematic pre-testing procedures, and post-testing procedures. Data will be collected from students currently enrolled in the Electronics Technology program and compared with industry standards to identify gaps and areas for curriculum improvement.

The increasing reliance on electronically controlled domestic appliances underscores the need for proficient troubleshooting skills among technicians. As technology advances, the gap between academic training and industry demands becomes more pronounced, highlighting the necessity for curriculum alignment. By addressing these issues, educational institutions like ZPPSU can better prepare their students for the real-world challenges they will face in the electronics industry, ensuring they possess the skills required to diagnose and repair complex electronic systems efficiently.

4. REVIEW OF RELATED LITERATURE

Importance of Troubleshooting Skills

Proficient troubleshooting skills are essential for identifying and resolving malfunctions in electronic appliances, gadgets,

and equipment. Common issues include blown fuses, tripped circuit breakers, and power surges, often requiring immediate attention to prevent further damage [4], [5]. Thus, effective troubleshooting ensures that defects are identified and fixed efficiently, maintaining the quality and durability of the appliances.

Essential Skills for Electronics Technicians

Electronics technicians must possess a diverse set of skills, including reading diagrams, assembling electronic units, and applying theoretical knowledge to practical situations. They must also perform preventive maintenance, calibrate equipment, and test electronic units using standard test equipment [1, 12]. These skills are crucial for diagnosing performance issues and making necessary adjustments to ensure proper functioning.

Critical thinking, complex problem-solving, and operation analysis are also vital skills for electronics technicians. These abilities enable them to determine the root cause of problems and take appropriate corrective actions [12]. Technicians must be adept at system assessment and quality control analysis to isolate and address system failures effectively.

Industry Requirements

In the global arena, the demand for skilled electronics technicians continues to grow. Technicians are expected to utilize various test equipment, develop and document test processes, and troubleshoot electro-mechanical assemblies, thus the modernization of professional training [13]. These tasks require a thorough understanding of basic electronics systems, components, and diagrams, as well as the ability to analyze test results and perform necessary adjustments [6].

Technological Advancements and Training

With the rapid development of technology, electronics technicians must continuously update their skills to keep pace with industry standards. Advanced training programs and certifications are crucial for maintaining technical proficiency and ensuring technicians can meet the evolving demands of the industry [13].

In the Philippines, the government emphasizes the need for vocational training programs that equip technicians with the necessary skills for the job market. These programs focus on developing expertise in using high-tech equipment and materials for repairing and maintaining electronic appliances [14].

Best Practices in Troubleshooting

Effective troubleshooting involves a systematic approach that includes initial problem identification, probing questions, and forming an effective plan of action [15]. Technicians must work with a high degree of accuracy and precision, conforming to detailed specifications and international quality standards [13]. Comprehensive troubleshooting procedures require critical thinking and system assessment to determine potential points of failure. By applying these techniques, technicians can isolate specific issues and implement targeted solutions, enhancing the reliability and performance of electronic appliances.

5. METHODOLOGY

Research Design

This study employs a descriptive research design to evaluate the troubleshooting skills of Electronics Technology students

concerning electronically controlled domestic appliances. Descriptive research is appropriate for providing an accurate portrayal of the characteristics, behaviors, or conditions of a particular population [16]. The research uses a quantitative approach, utilizing a survey questionnaire with a five-point Likert scale to measure the students' skills in repairing electronically controlled domestic appliances.

Research Environment

The study is conducted at Zamboanga Peninsula Polytechnic State University (ZPPSU), known for its technical and vocational programs in electronics technology. These programs are offered through the College of Teacher Education, College of Engineering Technology, and the Institute of Technical Education. Additionally, data collection extends to various service centres and electronic repair shops within Zamboanga City, providing a comprehensive view of the practical application of students' skills in real-world settings.

Respondents of the Study

The respondents consist of 61 graduate students enrolled in various electronics programs at ZPPSU. These programs include Bachelor of Technical Vocational Teacher Education (BTVTED), Bachelor of Science in Electronics (BSELEX), Diploma Technology (DT), and Associate Industrial Technology (AIT). The selection of respondents is based on census sampling, a technique recommended by Cochran [17] for ensuring that the entire population is represented, thus providing comprehensive insights into the students' skill levels.

6. RESEARCH INSTRUMENT

The primary research instrument is a researcher-constructed survey questionnaire designed to assess the competencies required for basic electronic troubleshooting. The instrument's development involved a thorough review of relevant literature and standards in electronic troubleshooting to ensure it accurately reflects the necessary skills and knowledge. The questionnaire was validated by experts in

Table 1 Basis for Analysis of the Data

Scale	Range	Descriptions		
		Tools & Equipment Knowledge	Use of Tools for	Diagnosis Procedures
1	1.00 - 1.75	Very Unknowledgeable	Below Average Skills	Below Average Skills
2	1.76 – 2.50	Unknowledgeable	Average Skills	Average Skills
3	2.51 – 3.25	Knowledgeable	Above Average Skills	Above Average Skills
4	3.26 – 4.00	Very Knowledgeable	Excellent Skills	Excellent Skills

7. RESULTS AND DISCUSSION

The perceived level of troubleshooting skills of the Electronics Students in Terms of Knowledge of Troubleshooting Tools and Equipment needed in Electronically-Controlled Domestic Appliances

The analysis of the knowledge of troubleshooting tools and equipment among Electronics Technology students reveals that the highest mean score was described as very knowledgeable ($M=3.82$) for the use of digital and analogue multitaskers, indicating that students are "Very Knowledgeable" in using these essential tools for measuring voltage, resistance, and current. This high proficiency is crucial as multitaskers are fundamental in diagnosing and

content and curriculum, ensuring its reliability and validity [17]. The survey employs a four-point Likert scale.

Data Gathering Procedure

Before administering the survey, the researcher sought permission from the college dean and the heads of the respective programs. This step ensured ethical compliance and cooperation from the academic units involved. Upon receiving approval, the researcher distributed the survey during class hours with the assistance of the electronics instructors. This method facilitated the smooth administration and timely collection of the completed questionnaires.

8. DATA ANALYSIS

The collected data were analyzed using mean and standard deviation, which are fundamental statistical tools for summarizing data and understanding variability within a dataset [19]. The mean provides a central tendency of the students' perceived knowledge and skills, while the standard deviation indicates the dispersion or variability of their responses. This statistical approach allows for a clear profiling of the student's abilities in troubleshooting various electronic devices and gadgets.

The methodology outlined ensures a robust and comprehensive assessment of the troubleshooting skills of Electronics Technology students at ZPPSU. By employing a descriptive research design, utilizing a validated survey instrument, and applying appropriate statistical tools, this study aims to provide valuable insights into the alignment between academic training and industry demands. This, in turn, will inform curriculum development and enhance the preparedness of graduates for the technical challenges in the electronics industry. Table 1 shows the interpretation of the data analysis.

- a. Identifying the uses of different types of tools
- b. Testing instruments for maintaining and repairing electronically controlled domestic appliances
- c. Applying symptom diagnosis and systematic pre-testing procedures

troubleshooting electronic circuits. Another tool with a relatively high mean score is the portable electric drill, which scored knowledgeable ($M=2.87$), signifying that students are "Knowledgeable" in its use. This tool is essential for creating holes in plastic and metal chassis, a common task in assembling and disassembling electronic devices. Similarly, the soldering iron and magnifying glass were described as knowledgeable ($M=2.85$) and ($M=2.86$), respectively, reflecting a good level of competency in performing basic soldering tasks and inspecting small components. Conversely, the lowest mean score was $M=1.88$ for the oscilloscope, indicating that students are "Unknowledgeable" about its use. Oscilloscopes are vital for observing voltage

waveforms and analyzing properties such as amplitude and frequency, essential for advanced troubleshooting and diagnostics. Other tools with low mean scores include the air-operated production desoldering system ($M=2.10$) and the hot air desoldering station ($M=2.42$), both falling under the "Unknowledgeable" category. The overall grand mean score

of $M=2.72$ suggests that, on average, students are "Knowledgeable" about using various troubleshooting tools and equipment. While this indicates a reasonable level of proficiency in basic tools, the lower scores in advanced tools highlight areas that require enhancement in the curriculum to ensure students are well-prepared for industry demands.

Table 2 Knowledge of Troubleshooting Tools & Equipment for Electronically Controlled Domestic Appliances of Electronics Technology Students

Troubleshooting Skills	Mean	Descriptive Rating
1. A digital multitasker and an analogue multitasker with an ammeter are used to check voltage, resistance, and current.	3.82	Very Knowledgeable
2. An oscilloscope is utilized to observe voltage waveforms and can be analyzed for such properties as amplitude, frequency, rise time, time interval, and distortion.	1.88	Unknowledgeable
3. Air Operated Production Desoldering System is very convenient in removing electronics components much more with the IC.	2.10	Unknowledgeable
4. A Hot Air Resoldering Station is used for resoldering and desoldering several components and is mostly used in rebelling IC.	2.42	Unknowledgeable
5. Soldering Iron is used to melt solder to form an electrical and physical connection between two surfaces.	2.85	Knowledgeable
6. A Desoldering Pump is used for the removal of solder and components from a circuit.	2.77	Knowledgeable
7. A portable Electric Drill is used for boring holes in the plastic and chassis with the used of drill bits	2.87	Knowledgeable
8. Driving tools such as Screw drivers may be Flat or Philip, Allen Wrench, and Precision are used to insert, tighten, loosen, and remove screws.	2.79	Knowledgeable
9. Magnifying Glass which is used to produce a magnified image of an object. It will show the defects that cannot be seen by the naked eye.	2.86	Knowledgeable
10. Splicing Tools such as the long nose, side cutter, and wire stripper are used for holding, bending, stretching and cutting of wires and lead terminals of electronic components.	2.84	Knowledgeable
11. Cutting Tools such as utility knife and hacksaw which is used to cut hard material.	2.70	Knowledgeable
Grand Mean	2.72	Knowledgeable

The perceived level of troubleshooting skills of the Electronics Students in Terms of Symptoms Diagnosis and Systematic Procedure in Electronically-Controlled Domestic Appliances

The analysis of students' troubleshooting skills in symptoms diagnosis and systematic procedures for electronically controlled domestic appliances reveals that the highest mean score was $M=2.87$, achieved for conducting resistance measurements. This indicates that students possess "Average Skills" in this area, which is crucial for identifying various faults such as short circuits, open circuits, and faulty components. High mean scores were also observed for dividing the system into sections for easier trouble identification ($M=2.84$) and for identifying system defects using appropriate tools and safety procedures ($M=2.84$). These skills are essential for systematic troubleshooting, careers.

ensuring the safety and accuracy of repairs, and highlighting the importance of detailed and methodical diagnostic processes.

Conversely, the lowest mean score was $M=2.65$ for circuit tracing to identify loose contacts and broken circuits, indicating this is an area where students show relatively lower proficiency. Despite this, the score still falls within the "Average Skills" category. The overall grand mean score of $M=2.78$ suggests that, on average, students exhibit "Average Skills" in symptom diagnosis and systematic troubleshooting procedures. This level of competence is adequate but indicates room for improvement to meet industry standards more effectively. Enhancing these skills through targeted educational interventions can better prepare students for complex troubleshooting tasks in their professional

Table 3. Troubleshooting Skills of the Students in Symptoms Diagnosis and Systematic Procedure in Electronically-Controlled Domestic Appliances

Troubleshooting Skills	Mean	Descriptive Rating
1. The system is being divided into sections for easy identification of trouble	2.84	Average Skills
2. Resistance measurement is often conducted in troubleshooting to further identify short circuits, open circuits, shorted components, open components, and leaky components and to locate associated parts	2.87	Average Skills
3. Circuit tracing is then conducted to identify loose contact, broken circuit, short circuit, and associated defective parts of Electronically Controlled Domestic Appliances	2.65	Average Skills
4. Voltage measurement is being conducted to detect insufficient voltage supply, no voltage supply, grounded circuit and open circuit of Electronically Controlled Domestic Appliances	2.80	Average Skills

5. Analyze and diagnose the trouble systematically and conduct the troubleshooting from end to end	2.79	Average Skills
6. The history of the product should be verified to have a good idea as to where or which section the troubleshooting to start	2.74	Average Skills
7. Control settings and adjustments are checked in conformity with the service manual	2.80	Average Skills
8. Diagrams in the service manual are being referred upon the conduct of troubleshooting	2.74	Average Skills
9. System defects are identified using appropriate tools and equipment and per safety procedures	2.84	Average Skills
10. Visual inspection is conducted to identify instantaneous defects like burn circuits, burn components, damaged and broken component	2.74	Average Skills
11. Defective parts and components are replaced with identical or recommended substitute	2.75	Average Skills
Grand Mean	2.78	Average Skills

The perceived level of troubleshooting skills of the Electronics Students in Terms of Troubleshooting skills of Students in Electronically Controlled Domestic Appliances

The analysis of students' troubleshooting skills in handling electronically controlled domestic appliances indicates that the highest mean score was 2.85 for both regulating the power supply before powering up after troubleshooting and evaluating the final product against its previous condition. These scores suggest that students possess "Average Skills" in ensuring that the power supply is stable and verifying that the repairs have effectively addressed the initial issues, which are critical steps in maintaining the functionality and safety of electronic appliances. These high scores highlight students' competence in fundamental safety and evaluation procedures, essential for reliable troubleshooting and repair.

Conversely, the lowest mean score was $M=2.64$ for observing systematic post-testing procedures per the manufacturer's instructions, indicating a lower proficiency yet still categorized as "Average Skills." This lower score points to a need for improved training in following detailed post-testing protocols, which are essential for ensuring comprehensive and consistent repairs. The overall grand mean score of $M=2.79$ suggests that, on average, students exhibit "Average Skills" in troubleshooting electronically controlled domestic appliances. While this indicates a baseline level of competence, it also underscores the need for enhanced training programs to elevate these skills to a higher standard, ensuring students are well-prepared for industry requirements.

Table 4. Troubleshooting skills of the Students in Electronically Controlled Domestic Appliances

Troubleshooting Skills	Mean	Descriptive Rating
1. The power supply is properly regulated before trying to power up after troubleshooting	2.85	Average Skills
2. Products are subject to final visual inspection and testing	2.72	Average Skills
4. The results of the diagnosis and testing are documented accurately and completely	2.82	Average Skills
5. The systematic post-testing procedure is observed the following manufacturer's instruction	2.64	Average Skills
6. Termination/connection has been done successfully	2.84	Average Skills
7. Parts replacement, electrical wirings, and mechanical assembly are correctly set in place to ensure there will be no back-job	2.82	Average Skills
8. Problems and faults detected during post-testing are resolved	2.79	Average Skills
9. Evaluate the final product against the previous condition	2.85	Average Skills
10. Final inspection is undertaken to ensure that the repaired product conforms to technical requirements	2.80	Average Skills
11. Soldered components are checked and complied iunder established standards and requirements	2.82	Average Skills
Grand Mean	2.79	Average Skills

9. LIMITATIONS OF THE STUDY

This study has several limitations that should be considered when interpreting the findings. The sample size was limited to 61 graduating Electronics Technology students from Zamboanga Peninsula Polytechnic State University, which may not represent all students in other institutions or regions. The reliance on self-reported data through a survey questionnaire, despite its validation, may introduce biases such as social desirability bias. The focus was exclusively on troubleshooting electronically controlled domestic appliances, omitting other relevant areas of electronics technology. Additionally, the cross-sectional design captures skills at a single point in time, just before graduation, without

accounting for changes and improvements over time or the impact of post-graduation experiences.

10. CONCLUSION

The study's analysis indicates a notable discrepancy in the knowledge and application of troubleshooting tools, diagnostic skills, and overall troubleshooting skills among Electronics Technology students. The students displayed strong proficiency in using basic tools such as digital and analogue multitaskers. However, their knowledge of more advanced tools like oscilloscopes highlights significant gaps in their training. This misalignment suggests that while students are competent in basic measurements and tasks, they

lack the necessary skills for advanced diagnostics and repairs, essential for meeting industry standards.

This misalignment extends to the students' diagnostic and troubleshooting skills. Despite an overall "Average Skills" rating, for diagnostic procedures and troubleshooting practices, the lower proficiency in systematic post-testing procedures reveals a critical area for improvement. Previous studies have emphasized the importance of aligning knowledge, diagnostic capabilities, and troubleshooting skills to achieve efficient and effective maintenance and repair [20], [21]. The findings suggest that curriculum enhancements are necessary to provide students with a balanced skill set [22], ensuring they can perform comprehensive diagnostics and repairs using both basic and advanced tools, ultimately leading to more efficient troubleshooting and higher employability in the electronics industry.

11. RECOMMENDATIONS

Based on the results and limitations of this study, the following are recommended.

Future research may include a larger, more diverse sample of Electronics Technology students from various institutions and regions to enhance generalizability and incorporate continuous assessment and observational methods alongside self-reported data for a more accurate evaluation of competencies. Longitudinal studies tracking skill development from enrollment through professional careers would offer valuable insights into the long-term effectiveness of educational programs.

The Electronics Technology curriculum may be revisited to align with industry demands, focusing on advanced troubleshooting tools where current knowledge is lacking and including modules on digital electronics, microcontroller programming, and advanced circuit design for a comprehensive skill set. Integrating systematic post-testing procedures and detailed diagnostic protocols into the curriculum will help students develop thorough and reliable troubleshooting techniques.

Targeted training programs and workshops on advanced troubleshooting tools and systematic diagnostic procedures can significantly enhance students' skills; while prioritizing professional development opportunities for instructors ensures they stay current with technological trends and industry practices. Establishing partnerships with industry professionals will provide students with real-world insights and practical experiences, enhancing their readiness for the workforce.

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