
TROUBLESHOOTING SKILL ACQUISITION NEEDS OF VOCATIONAL TEACHERS: IMPLICATION FOR AN UNINTERRUPTED PRACTICAL TEACHING

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Abstract

Faults in equipment and simple machines are not predictable due to the various components working together as a system. Since faults in a system could be impromptu and without prior notice, vocational teachers ought to be equipped with troubleshooting strategies that are easy to recall for diagnosing and fixing common faults in any electronics, automotive or mechanical systems that are used in the teaching/learning process. Fault finding often poses various challenges to vocational teachers who are not skilled in troubleshooting concepts, especially during lesson delivery. When fault or failure occurs during the process of teaching and learning, the vocational teacher is confronted with the challenge of knowing how to detect, locate and rectify the fault within the shortest period of time to avoid interrupting the lesson. The teacher is expected not only to attempt to solve the problem at hand, but also to follow the correct sequence of fault diagnosis without damaging the equipment or system. This article critically looks at some fault diagnosis strategies which were infused into the practice of Nigerian technical college teachers in addressing faults that occur during teaching and learning process.

Keywords: Troubleshooting skills acquisition, Troubleshooting skills strategies, Nigerian vocational teachers, practical teaching.

Introduction

The National Policy on Education, of the Federal Republic of Nigeria (2013) has made it mandatory as one of its goals for Technical and Vocational Education the acquisition of Technical & Vocational skills for commercial and economic development of the nation. In pursuance of such goal, the curriculum encourages effective participation of students and teachers in practical work. Among the required skill in such system is the effective handling of tools, machines and equipment in the practical class. This situation calls for vocational teachers to acquire certain level of skills that will enable

them to handle instructional aids during the teaching & learning process.

The place of acquiring fault diagnosis and repair of instructional aids (also known as troubleshooting skill) in vocational education to present and future progress of educational system and the nation cannot be overemphasized. The implication and impact of such skill is so enormous for vocational teachers' effectiveness and the development of the nation's educational system. The global focus on pragmatic approach to teaching will be achieved, and it will foster uninterrupted practical lesson for vocational teachers.

Why Troubleshooting Skill?

What makes equipment's fault diagnosis and repair skill acquisition unique for vocational teachers can be observed from its fundamental meanings and concepts. Failures and faults in equipment and simple machines or instructional aids are not predictable because of the various components working together as a system. This situation always poses a lot of challenges and difficulties to vocational teachers who are not skilled in troubleshooting concepts especially during lesson delivery. Liang (2012) observed that development of knowledge and skills such as in the case of troubleshooting is one of the objectives of training technicians and technologist.

Troubleshooting skills also referred to as fault diagnosis and repairs skills form the basis of maintaining equipment and devices. It could either be troubleshooting a mechanical device, electronic or electrical system. The purpose is solving a problem or checking the misbehavior of the system against expected behavior until the fault is located and rectified. Whether a faulty power generator, projector, Liquid Cristal Display (LCD) television or computer unit, troubleshooting attempt to check the circuit behavior one by one to isolate the faulty state in order to restore the system back to normal functioning.

In this article, troubleshooting is the complete process of identifying the symptoms of a fault to the taking of appropriate corrective actions on a system (Schaafstal, Schraagen & Van Berlo, 2000). Troubleshooting involves using procedures to isolate and identify what is wrong with a device that used to work and repairing or replacing that part or subsystem to fix the device (Crismond, 2013). Crismond referred

to the art of troubleshooting as a bridge that connects engineering design and scientific inquiry. To troubleshoot effectively, students need to know and use many concepts from science, technology, engineering and mathematics disciplines as well as have knowledge of materials, construction techniques, and tools for exploring the devices, including mathematical models (Crismond, 2013). Effective troubleshooting is all about checking a circuit or system behavior against your expectations, one by one, until you find one that does not match (Johnson, 1995).

When faults or failure occurs, during the process of teaching and learning, the vocational teacher is confronted with the challenge of how to detect, locate and rectify the fault within the shortest period to avoid interruption in the lesson. The teacher is expected not only to attempt to solve the problem at hand but also to follow correct sequence of fault diagnosis skill without damaging the equipment or system.

Troubleshooting is a common form of problem solving skill. It is a means of diagnosing and detecting faults in equipment or a machine. Troubleshooting attempts to isolate faulty state in a system repair or replace the faulty components in order to reinstate the system to normal functioning (Ottosen, 2012; Dounas-Frazer and Lewandowski (2017).

Troubleshooting is normally associated with the repair of physical, mechanical or electronic systems. According to Jonassen (2011), troubleshooting problems are in between well structured (i.e. algorithms) and ill – structured (system analysis, design) on the continuum of problems in devices or system.

Challenges in Fault Diagnosing and Detecting.

Most modern technologies applied in designing equipment and tools are becoming complex and difficult for a novice to operate (IDC, 2016; Tafur, Evangelou & Strobel, 2012). Inability of the users to handle it when it suddenly develop a fault usually translates into loss of productivity, damages and bringing down the reputation of the user. This is as a result of the fact that troubleshooting or fault diagnosing and detecting is always accompanied with certain peculiar problems, such problems highlighted by Jonassen and Hung (2006) and Jonassen (2010) and include:

- ❖ It sometimes appear ill – defined because the troubleshooter must determine what information is needed for problem diagnosis.
- ❖ It requires the construction of a conceptual model of the system being troubleshoot (i.e. how the sub-systems in a system interact).
- ❖ It usually possess a single fault state, although multiple faults may occur simultaneously (e. g. faulty fuse, or battery, short-circuit e. t. c.)
- ❖ It has known solutions with easily interpreted success criteria.
- ❖ It rely most efficiently on experience – based rules for diagnosing most of the cases, making it more difficult for novices to learn.
- ❖ It requires the learners to make judgments about the nature of the problem, and
- ❖ Vary significantly in terms of system complexity and dynamicity.

Troubleshooting is predominantly a cognitive task that include the search for likely causes of faults through a potentially enormous problem space of possible causes (Schaafstal, et al., 2000). It is therefore obvious that before operating an equipment

for instructional purpose, the user ought to possess some basic troubleshooting knowledge and skills to apply whenever faults or failure occur.

Basic Knowledge and Skills Required to Troubleshoot

Fault diagnosing and detecting is usually taught as a linear series of decisions that direct the fault isolation. This flowcharts and decision tables are usually recommended to lead beginners through a series of actions that will isolate and detect the fault.

The form of troubleshooting skill required for vocational teachers is the beginners' troubleshooting skill. Although, fault diagnosing and detecting skill acquisition is a holistic activity rather than a specific practical task (Bukar, 2000). Vocational teachers should see it as a task that involves the combination of all the three domains of learning. Fault diagnosis predominantly requires the ability to reason quickly and apply the known principles through critical observation of components characteristics and use of suitable test instruments using few manual skill (Jonassen, 2011).

Some technical experts have identified the basic knowledge and skills required in troubleshooting. As reported by Ericsson and Smith (1991), the following kinds of basic system knowledge are most generally accepted as essential for troubleshooting:

- i) The domain knowledge: this refers to the general theories and principles upon which the system or devices was designed.
- ii) System/devices knowledge: this is the conceptual knowledge of how a system works. System or device knowledge is an understanding of the structure of the system, the function of the components within the system and the behavior of the components as they interact with

other components in the system (IDC, 2016).

- iii) Performance/procedural knowledge: this involves the task performance required and procedures that must be known and practiced. Dounas-Frazer and Lewandowski, (2017) argued that procedural knowledge is specific to the system and the tools used to troubleshoot it.
- iv) Strategic knowledge: strategic knowledge plays an essential role in troubleshooting by reducing the problem space, isolating the potential faults and testing and evaluating hypothesis and solutions. Dounas-Frazer & Lewandowski (2016) argue that beginners in troubleshooting skill's learning requires strategic knowledge because, it helps the troubleshooters confirm the hypothesis and solutions they have generated or seek new alternatives when the existing hypothesis or solutions are confirmed false or unfeasible.

Jonassen and Hung (2006) classified the skills required for Technical troubleshooting and stressed that technical trouble shooting skill is a form of problem solving skill. Technical fault diagnosing, detecting and repairs has to do with the ability to detect, locate and rectify faults in electronics, mechanical and automotive systems, especially as it concerns educational aids, such as projector, generator, television, monitors, personal computer and many others.

Based on evidence gathered from past exploratory studies, five factors were linked with technical fault diagnosing and detecting skill. Highlighted among these factors are the technical fault diagnosis experience, cognitive skill, critical thinking

skill, cognitive style and problem solving style skill (Jonassen & Hung, 2006, p. 104). When technicians and trainers were assessed based on these variables, the six skills were ranked according to their level of importance in troubleshooting process. Years of experience was the strongest indicator of technical fault diagnosis skills. Findings indicate that a solid base of content knowledge is necessary in order to be skilled enough to solve technical fault problems. Cognitive technical knowledge proved to be an effective Predictor of technical fault diagnosis skills and ranked second. When the assessment were analysed, the strongest correlation was between cognitive technical knowledge and the information acquisition dimension. Critical thinking skills factor was found to be an effective predictor of trouble shooting skills. It ranked third. Findings have well revealed that combination of the first three factors serve as particular strong indicators of technical troubleshooting capabilities (Rivera-Reyes & Boyles, 2013). Cognitive style is field dependence. It is not all that an effective predictor of trouble shooting skills. Problem solving style was found to be the least important indicator to acquire an effective technical fault diagnosis and repair skill.

Models for troubleshooting

Although, various instructional models have been developed for troubleshooting by researchers, none of these models integrated the different knowledge states, especially the experiential knowledge which was incorporated by Jonassen and Hung (2006). These authors proposed that the process of learning how to troubleshoot must include the five steps of troubleshooting process. These include, constructing the problem space, identifying fault symptoms, examining and diagnosing fault(s), generating and verifying solutions,

and recalling the previous experiences. These steps are followed sequentially based on the state of the system that requires troubleshooting until the fault(s) are removed and the system restored to normal functioning.

In a latter development, Ross and Orr (2009) advanced troubleshooting model and emerged with a six-steps standardized troubleshooting model referred to as the DESCAR model. It was an improvement on the Jonassen and Hung (2006) model which increased the troubleshooting skill abilities of college students in Information and Technology profession. The DESCAR model was integrated into the standard curriculum of an information technology program at a large college and was found that there was improvement in several areas of troubleshooting where the model was reinforced. DESCAR model (Figure 1) comprised of six steps which encourage students to deliberately get engaged in the troubleshooting process.

The steps include, defining the problem; examine the situation; consider the causes; consider the solution; act and test and finally review the troubleshooting process. The different stages of the troubleshooting process are comparable to those found in other methods. The specific contribution of the DESCAR model is the inclusion of a more cyclical process by means of backward steps and the explicit recommendation to use the method in an interpersonal context (Ross & Orr, 2009). A critical analysis of the models revealed that, the art of troubleshooting is not just a physical task; rather it is a combination of cognitive, affective and psychomotor domains.

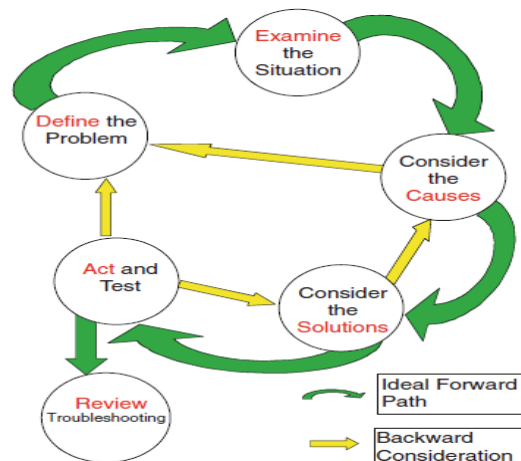


Figure 1: DESCAR Model of Troubleshooting by Ross and Orr (2009)

The necessity of adequate troubleshooting skill for vocational teachers

The instructional process will not be effective if the instructor or teacher is poorly qualified and ill equipped with the technical knowledge of the equipment being utilized. When a vocational teacher does troubleshooting such as in the beginner’s level, the output of the process provide feedback to the troubleshooter and enhances the skill and confidence to conduct an uninterrupted teaching and learning process. Tafur, Evangelou and Strobel (2012) argues that through the process of fixing a faulty artifact or equipment, the individual can close the gap in his or her technological problem-solving literacy. Teaching and instructing principles require among other things that, the learning process should among others; (i) address challenging problems which helps to stimulate learning, (ii) enhance effective transfer of learning, (iii) be a process of the whole individual that operates with least possible interruption and (iv) be logical and orderly (Rosenshine, 2012)

In order to achieve the purpose of learning by vocational teachers, the above principles suggest the need for adequate fault diagnosis, detecting and repairs skill so as to

avoid common problems of interruption that usually occur when teaching and training process is in progress. The vocational teacher who has possessed the basic knowledge and skill in technical fault diagnosis and repairs ensure any problem(s) emerging from the instructional aid is solved without interfering with the process of teaching. Since fault(s) in a system could occur impromptu without prior notice, the vocational teachers ought to be equipped with some easy to recall steps for diagnosing and fixing common faults in any electronics, automotive or mechanical systems that is used in the teaching/learning process. The following algorithms were infused into the technical college students' programme and were found productive and efficient for novices and beginners in troubleshooting skills.

Three basic Television system problems and troubleshooting algorithms identified in this article include:

1. Common problems with LCD Television/Computer Monitor Unit
2. Connection problem.
3. Video/Colour problem.

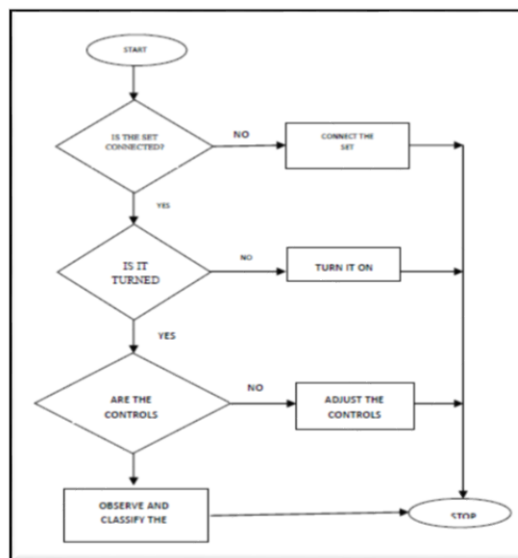


Figure 2: Flowchart for locating common problems in Television/ Computer Monitor Unit

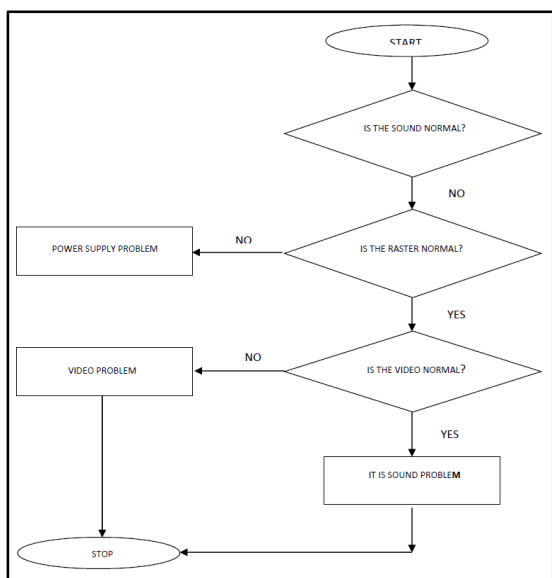


Figure 3: Flowchart for Locating Connection

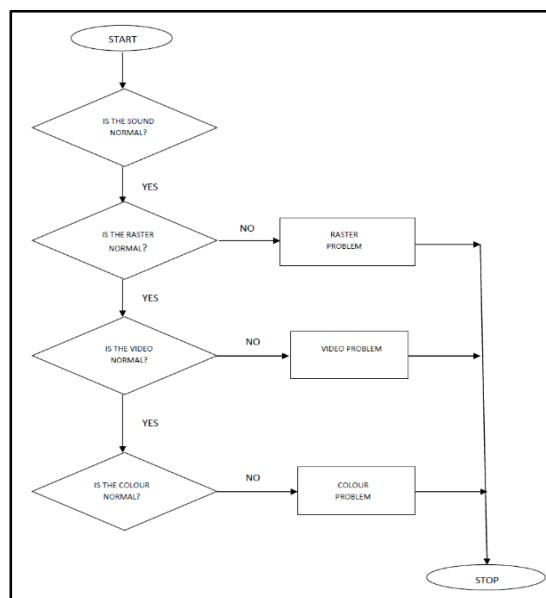


Figure 4: Flowchart for Locating Video Problem Problem

Table 1: Basic Generator troubleshooting tips

Problems	Cause	Correction
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Engine is running but no AC output is available	One of the circuit breakers is open. Fault in generator. Poor connection or defective cord set. Connected device is bad.	Reset the circuit breaker. Contact authorized Technician Check and repair. Connect another device that is in good condition.
Engine runs good at no load but "bogs down" when loads are connected.	Short circuit in a connected load. Engine speed is too slow. Generator is overloaded; Shorted generator circuit. Clogged or dirty fuel filter.	Disconnect shorted electrical load. Contact authorized Technician Reduce the load. Contact authorized Technician Clean or replace fuel filter.
Engine will not start; or starts and runs rough.	Start switch in off (O) position. Fuel valve is in "Off" position. Failed battery Low oil level Out of fuel	Turn key in Start switch (I) to run. Turn fuel valve to 'ON' position. Replace battery. Fill oil to proper level. Fill fuel tank.
Engine shuts down when running.	Load is too high. Dirty air filter. Dirty fuel	Reduce the load to manual specification. Replace air filter. Clean or replace filter.
Engine 'hunts' or falters	Clogged or dirty fuel filter. Carburetor is running too rich or too lean.	Clean or replace fuel filter. Contact expert.

Source: www.auroragenerators.com

Troubleshooting as described in figures 1 to 3, and Table 1 shows the quick-to-apply strategies for developing problem-solving skills by vocational teachers. These are needed to increase the problem solving skills and literacy of non-engineers and technologists.

Conclusion.

Training of vocational teachers who are not specialized in maintenance and repairs of electrical/electronics and mechanical instructional materials and equipment will be inadequate if there is no basic knowledge of troubleshooting skills of commonly used equipment in the classroom for lesson delivery. It is therefore obvious that troubleshooting skill acquisition needs of vocational teachers is an essential aspect of

effective service delivery. This knowledge and skill if acquired will enhance efficient and uninterrupted teaching and learning. Vocational teachers require this skill to make them better in their job.

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