

# **Automobile Starting and Lighting System Maintenance Training Manual for Effective Learning of Motor Vehicle Mechanics Work in Technical Colleges**

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## **Abstract**

The purpose of this study is to develop automobile starting and lighting system maintenance training manual for technical college students. Research and Development (R and D) design was adopted for the study. The population of the study is 348, comprising of 76 auto-mechanics teachers, 36 automobile supervisors and 237 students from all the technical colleges in North-Western States of Nigeria. There was no sample for the study; however, purposive sample was used for the students used for trial testing. Six research questions and a null hypothesis guided the study. The instruments for data collection are; Auto-Electricity Training Manual Questionnaire (ATMQ), Auto-Electricity Psychomotor Test (APT) and Auto-Electricity Rating Scale (ARS). The ATMQ, APT and ARS were subjected to face validation by five experts from the University, Technical Colleges and the Automobile Industry. The ATMQ was trial tested on students of Government Technical College Minna and Automobile Supervisors in automobile companies in Minna to establish its reliability. Cronbach Alpha was used to establish the reliability of ATMQ, sections B, C, D, E and F yielded coefficient of 0.72, 0.81, 0.76, 0.78 and 0.73 respectively. Kendall's coefficient of concordance was used to establish the internal consistency of APT and yielded coefficient of 0.75. Data were analyzed using mean and standard deviation, while ANCOVA was used to test the hypothesis which yielded a coefficient of 0.044 at 0.05 level of significance. The study developed training manual for automobile starting and lighting system with pictorial illustrations for technical colleges. The use of automobile starting and lighting system of training manual is therefore recommended for practical skills training in technical colleges, so as to achieve their objectives.

**Keyword: Automobile, Starting, Lighting System, Maintenance, Training Manual, Technical College**

## **Introduction**

The programme for motor vehicle mechanics work in Nigeria technical colleges is designed to produce competent craftsmen that can test, diagnose, service and completely repair any fault on motor vehicle to the manufacturer's specification (National Board for Technical Education (NBTE) 2001). The aim of motor vehicle mechanics practice is to give training and impart the necessary skills leading to the production of craftsmen, technicians and other skilled personnel who will be enterprising and self reliant (NBTE, 2003). Technical colleges are post primary schools where students learn skills in various

occupations. According to Bakare (2009), technical colleges are charged with the responsibility of producing craftsmen. Auto-mechanics craftsmen who undergo training in motor vehicle mechanics work are expected to possess work skills for success in automobile starting and lighting system and other aspect of automobile maintenance and repairs. However, in spite of the turnout of auto-mechanics students from technical colleges over the years, it has been observed that most of the auto-mechanics students could not apply their knowledge and skills to solve problems in automobile starting and lighting system effectively (Opeyemi, 2005). Umar (2009) stated that in most technical colleges, classes are mostly conducted in theoretical form and students do not have the opportunity to apply what they learnt in solving new/unfamiliar problems. There appears to be gaps between the training acquired by technical college students and the skills required for new technologies in motor vehicle electrical system. This inadequate skills acquired by technical college students could be because of insufficient time allocated for practical classes, lack of materials, tools and equipment to conduct practical and expertise to conduct practical classes in technical colleges. This is evident in technical colleges where several subjects offered in the schools are contending for time, this insufficient time necessary for practical work may have resulted in poor skills acquisition (Audu and Umar, 2006). In addition, technological advancement in the work place and industries also necessitated a need to equip auto-mechanics students with workplace basic skills which will make them adaptable to the present and envisaged future changes in motor vehicle.

However, urgent steps need to be taken to address this ugly trend. One way of doing this, will be the development of a training manual to fall back on during and after classes. Training manual which can also be self-instructional manual is an instructional guide developed to help the learner or user acquire mastery of certain technical skills or tasks. Training manual according to Lan (2007) is a set of instructional manual that provide guidelines on how to carry out specific and general operations on assigned job. A good training manual should focus on the basic components of auto-electricity such as starting and lighting system. Starting system is provided in the vehicle as a means of starting the engine. It is bolted to the lower rear part of the engine. The starting system consists of the battery, starter motor, solenoid, ignition switch and automatic transmission switch. Often, determining which part is at fault when the engine will not crank is more difficult than replacing the defective parts. Many complaints of poor starter performance are traced to a discharged or defective battery. Proper starter system and lighting system performance demands a charged and efficient battery. (Stockel et. al. 1996).

The lighting system is provided to give illumination so that the driver can see at night or in darkness and also provide other road users information and the direction at which the vehicle is turning. Lighting system circuit consists of the battery, switch and lamp (bulb). The modern headlight of most vehicles is of sealed beam construction. The filament, reflector and lens are fused into one airtight unit. Prongs that fit into a socket connector make removal easy. Lighting bulbs used throughout in the car are of the single or double contact type. The lighting circuits are of vital importance. It must be properly maintained. In addition to the basic components, a training manual in auto-electricity according to Johnson (2001) should include the; Objective of the training manual, teaching strategy, training materials and method of evaluating the trainees.

The objective of any educational process determines the content, method and materials needed for achieving such objectives. Alabi, (2005) stated that, objectives are

stated in a precise, clear, and measurable terms in order to achieve the goal for which it is meant to achieve. The objective of this training manual is to develop adequate skills necessary for smooth transition of auto-electricity/electronics students from to school to workplace. Objectives of the training manual could be achieved by employing different teaching strategies. Teaching strategy refers to a plan that is intended to achieve a particular purpose (Okwori, 2009). Audu and Umar (2006) noted that strategies adopted by teachers are contributing factors to the knowledge and skills acquisition of technical college students. Evaluation connotes examining or judging the worth or quality of something. Okoro (2002) defined evaluation in education as the process of passing judgment on the adequacy of the scores or marks obtained by a student in a measurement process. Evaluation therefore, refers to appraisal of skills in automobile starting and lighting system with the objective of measuring learning outcome and improving instruction, and providing feedback in automobile starting and lighting system maintenance.

Maintenance can be described as a way of repairing or servicing used equipment or machine in order to make for enhanced functioning capacity. Maintenance training manual is a complete self-directed training system or text of instruction addressing a broad range of maintenance and skills related topics (Mohammed, 2008). The training manual in automobile starting and lighting system maintenance provides organized skills delivery system to assist auto-mechanics technology teachers in their lesson delivery and also enhance student's skills acquisition.

### **Statement of the Problem**

A well trained auto-technician is expected to carry out operation in all electrical components of motor vehicle, trace and rectify fault. However, most auto-mechanics students and auto-electricians do not seem to adequately achieve this. This is because most of them who are employed do not have adequate and requisite practical skills and knowledge necessary to progress in their chosen field and to carry out automobile starting and lighting system repair, they mostly engage in trial and error to rectify faults. One ways to curb these problems will be to develop a training manual in automobile starting and lighting system that will provide enough information to guide both the teachers and learners in the course of auto-electricity/electronics maintenance. The use of training manual may guide and overcome these problems when carrying out maintenance in automobile starting and lighting system and also help auto-mechanics students learn more quickly and acquire necessary skills and knowledge thereby making them to be employable.

Therefore, the problem of this study is that auto-mechanics students do not have the requisite practical skills in automobile starting and lighting system maintenance and repairs. The general purpose of the study is to develop automobile starting and lighting system maintenance training manual for technical college students.

### **Research Questions**

The following research questions were formulated to guide the study.

- i. What are the objectives for automobile starting and lighting system training manual?
- ii. What is the content of automobile starting and lighting system training manual?
- iii. What teaching strategies are required for automobile starting and lighting system training manual?
- iv. What training materials are required for automobile starting and lighting system training manual?

- v. What evaluation criteria are required for automobile starting and lighting system training manual?
- vi. How effective is the developed automobile starting and lighting system training manual?

**Hypothesis**

The null hypothesis formulated was tested at 0.05 level of significance:

Ho. There is no significant different between the mean performances of students taught with the developed manual and those taught without manual.

**Methodology**

This study adopted Research and Development (R and D) design. Gall et. al. (2007) described Research and Development as an industry based development approach involving the use of research findings to design and develop new programmes and materials which assist in improving knowledge and skills. In this study, the seven steps of Gall et al (2007) were articulated into three phases as follows: Need assessment, Development of the manual and Validation of the manual. The study was conducted in North-Western States of Nigeria. Also, accredited National Board for Technical Education (NBTE) technical colleges offering auto-mechanics work at NTC level in these States was covered. The population for this study is 348, comprising of all the 75 auto-mechanics teachers, 237 NTC III students (2012/2013) session of the 17 technical colleges offering motor vehicle mechanics and 36 automobile supervisors. The entire population was studied, while a purposive sampling was adopted for selecting students for the study. Government Technical College, Malali, Kaduna and Kano NTC III students were used to determine the effect of the developed training manual. The instruments used for data collection in this study were developed by the researcher, these are; Auto-Electricity/electronics Training Manual Questionnaire (ATMQ), Auto-Electricity/electronics Psychomotor Test (APT) and Auto-electricity/electronics Rating Scale (ARS). The Auto-Electricity/electronics Training Manual Questionnaire (ATMQ) was a structured questionnaire containing 273 items divided into six sections, A to F respectively.

The instruments were face validated by five experts in auto-mechanics. Cronbach Alpha was used to determine the internal consistency of the instrument. Sections B, C, D, E and F yielded a reliability coefficient of 0.72, 0.81, 0.76, 0.78 and 0.73 respectively. While the inter-rater reliability APT was obtained using Kendall’s Coefficient of Concordance. A coefficient of 0.75w was obtained. The researcher personally administered copies of the questionnaires to the respondents (auto-mechanics teachers and automobile supervisors) with the help of seven research assistants (RAs). Research questions, 1, 2, 3, 4 and 5 was analyzed using mean and standard deviation, While the hypothesis formulated to guide the study was tested at 0.05 level of significance using ANCOVA.

**Results**

**Research Question 1**

What are the objectives for automobile starting and lighting system training manual?

**Table 1**

**Mean and Standard Deviation of Respondents on the Objectives for Automobile Starting and Lighting System Training Manual N = 105**

	Objectives	Mean	SD	Remarks
1	Provide a step by step outline of the procedures for troubleshooting problems in an automobile starting and lighting system	4.16	1.12	Agree
2	Provide auto students and auto technician with the skills and knowledge required to diagnose and repair vehicle with electrical system malfunction	4.36	1.16	Agree
3	Develop adequate skills necessary for smooth transition from school to workplace	4.77	0.52	Strongly Agree
4	Enhance teacher’s skills in teaching auto-electricity/electronics	4.59	0.94	Strongly Agree

5	Provide employability skills to auto-electricity/electronics students	4.74	0.56	Strongly Agree
6	Enhance the use of diagnostic tools/facilities/equipment	4.90	0.38	Strongly Agree
7	Accurately troubleshoot the problem, and avoid misdiagnose	1.53	0.68	Disagree
8	Supplement job experience of students from the industry	4.31	1.03	Agree
9	Improve students' interest in auto-electricity/electronics	4.83	0.38	Strongly Agree
10	Enhance opportunity to progress in their educational pursuit	1.55	0.66	Disagree
11	Guide the students in acquiring auto-electricity/electronics technology skills	4.84	0.44	Strongly Agree

Table 1 revealed that, of the 11 objectives of starting and lighting system maintenance, the respondents strongly agree with 6 out of the 11 items. Their mean responses were between 4.50 – 5.00. Items 1, 2, and 8 with mean responses of 4.16, 4.36, and 4.31 respectively were considered agree by the respondents. However, they disagree with items 7 and 10 due to low mean responses of 1.53 and 1.55 respectively. The standard deviation (SD) of the items ranged from 0.38 to 1.16, implying that the respondents were very close in their rating.

### Research Question 2

What is the content of automobile starting and lighting system manual?

**Table 2**

### Mean and Standard Deviation of Respondents on the items for Starting System Maintenance N = 105

	Starting	Mean	SD	Remarks
12	Disconnect the battery ground cable	4.94	0.23	Strongly Agree
13	Disconnect the starter motor cables from its terminals	4.95	0.21	Strongly Agree
14	Remove the starter motor assembly	5.00	0.00	Strongly Agree
15	Installation is in reversal order of the removal	4.97	0.29	Strongly Agree
16.	Disconnect the starter cable from its terminal	4.98	0.20	Strongly Agree
17.	Connect a 12V battery between	4.99	0.10	Strongly Agree
18.	If the switch is turned ON, the pinion is moving. CAUTION: This test should be done as soon as possible not to damage the coil (in 10 seconds)	4.99	0.10	Strongly Agree
19.	Check the space between pinion and stopper ring using a feeler gauge. If it is out of standard, adjust clearance by adding or removing the washer between the magnetic switch and the bracket	5.00	0.00	Strongly Agree
20.	Remove the stop ring by moving it to the pinion side	5.00	0.00	Strongly Agree
21.	Then remove the stop ring from the shaft	5.00	0.00	Strongly Agree
22.	Check for continuity between the commutator and the armature coil using a circuit tester; if there is continuity, replace the rotor assembly	4.99	0.10	Strongly Agree
23.	Inspect the armature coil in the growler and if there is short circuit, replace the coil	4.99	0.10	Strongly Agree
24.	Rotate the armature in the growler, if the blade attached in the core vibrates, the armature is short-circuited	5.00	0.00	Strongly Agree
25.	Check for continuity between the commutator segments using a circuit tester. If there is no continuity, replace the armature assembly owing to open circuit of commutator segment	4.96	0.31	Strongly Agree
26.	Check for continuity of the field using a circuit tester. If there is no continuity, replace the field assembly owing to open circuit of the field coil	4.98	0.14	Strongly Agree
27.	With the yoke coil installed, inspect for continuity between the field coil and the yoke, if there is continuity, replace the field coil	4.83	0.61	Strongly Agree
28.	Loose the brush holding screws from the plate	4.90	0.31	Strongly Agree
29.	Unsolder and remove the worn brush	4.78	0.59	Strongly Agree
30.	Clean the brush seating	4.86	0.35	Strongly Agree
31.	Clean the pigtail with sand paper	4.67	0.72	Strongly Agree
32.	Solder the pigtail and the new brush	4.84	0.37	Strongly Agree
33.	Return the brush to its seating	4.83	0.40	Strongly Agree
34.	Tighten the screws	4.89	0.35	Strongly Agree
35.	Use hammer to tap the bushing and remove it	4.81	0.50	Strongly Agree
36.	Press-fit a new bushing	4.89	0.47	Strongly Agree
37..	Remove battery positive and negative ground cables.	4.85	0.53	Strongly Agree
38.	Unscrew the starter nuts from the clamp	4.85	0.53	Strongly Agree

39.	Remove the field coil strap from the solenoid terminal	4.83	0.56	Strongly Agree
40.	Remove the attaching screws and bolts	4.85	0.53	Strongly Agree
41.	Remove the solenoid housing	4.90	0.43	Strongly Agree
42.	Install the new solenoid in the reverse order of removal	4.90	0.43	Strongly Agree
43.	Reconnect the cable and wiring after installation of the starter	5.00	0.00	Strongly Agree
44.	Reconnect the ground cable to the battery	5.00	0.00	Strongly Agree
45.	Locate the vehicle interface connection port (outlet)	5.00	0.00	Strongly Agree
46.	Connect the interface to the computer USB port and vehicle connection port	5.00	0.00	Strongly Agree
47.	Turn the vehicle ignition on	5.00	0.00	Strongly Agree
48.	The computer will display a home page, then select the type of vehicle	5.00	0.00	Strongly Agree
49.	Enter the vehicle information number (VIN), locate by the front windscreen or front door hinge	4.98	0.14	Strongly Agree
50.	Vehicle information will be display on the computer	4.96	0.19	Strongly Agree
51.	Navigate using computer keyboard and locate fault reading	4.90	0.31	Strongly Agree
52.	Fault codes will be displayed as shown, reading permanent fault. Repairs are to be carried out at this point	4.86	0.35	Strongly Agree
53.	After repairs, the fault codes will displayed as shown, reading intermittent fault	4.82	0.39	Strongly Agree
54.	Navigate to select clear fault codes	4.75	0.55	Strongly Agree
55.	Carrying out clearing fault will be displayed	4.70	0.57	Strongly Agree
56.	No fault found will be displayed after clearing of fault	4.53	0.88	Strongly Agree

The data presented in Table 2 show that, all the 45 items on starting maintenance had their mean responses above 3.50 – 5.00 on a 5 point scale were considered strongly agree. This implies that, the respondents strongly agree with the items as appropriate for inclusion in the starting maintenance. The standard deviation (SD) of the items ranged from 0.00 to 0.88, implying that the respondents were very close in their rating.

**Table 3**

**Mean and Standard Deviation of Respondents on the items for Lighting System Maintenance N = 105**

	<b>Lighting</b>	<b>Mean</b>	<b>SD</b>	<b>Remarks</b>
57.	Open the vehicle hood (bonnet)	4.54	0.88	Strongly Agree
58.	Look for the bulb holder at the back of the headlight	4.50	0.97	Agree
59.	Remove the wire from the bulb holder	4.49	0.97	Agree
60.	If the holder has a plastic catch, simply press the lever on the top of the plug and pull firmly on the plug. If the holder has a metal clip, just pull up away from the holder. If the holder has a screw cap, simply unscrew it	4.37	1.13	Agree
61.	Remove the dust cover	4.39	1.16	Agree
62.	Pull the old bulb out of the holder	4.39	1.15	Agree
63.	Using a clean rag, wipe down the bulb holder	4.45	1.11	Agree
64.	Insert the new bulb into the bulb holder	4.50	0.98	Strongly Agree
65.	Return the dust cover	4.59	0.92	Strongly Agree
66.	Plug the wiring back in and secure the bulb	4.60	0.84	Strongly Agree
67.	Test to make sure it works	4.55	0.85	Strongly Agree
68.	Locate your fuse box under the dashboard on the driver's side or in the bonnet	4.65	0.65	Strongly Agree
69.	Open the box and locate the fuse that looks melted. Most fuse boxes have a diagram, so if headlight goes out, you can easily look at the diagram to make sure you are replacing the fuse that goes with the headlights	4.67	0.55	Strongly Agree
70.	Pull the bad or blown fuse out	4.78	0.42	Strongly Agree
71.	Replace the blown fuse with a new fuse of the same colour and wattage	4.68	0.56	Strongly Agree
72.	Locate the vehicle interface connection port (outlet)	4.79	0.41	Strongly Agree
73.	Connect the interface to the computer USB port and vehicle connection port	4.80	0.40	Strongly Agree
74.	Turn the vehicle ignition on	4.87	0.34	Strongly Agree

75.	The computer will display a home page, then select the type of vehicle	4.89	0.32	Strongly Agree
76.	Enter the vehicle information number (VIN), locate by the front windscreen or front door hinge	4.81	0.46	Strongly Agree
77.	Vehicle information will be display on the computer	4.88	0.33	Strongly Agree
78.	Navigate using computer keyboard and locate fault reading	4.78	0.64	Strongly Agree
79.	Fault codes will be displayed as shown, reading permanent fault. Repairs are to be carried out at this point	4.89	0.40	Strongly Agree
80.	After repairs, the fault codes will displayed as shown, reading intermittent fault	4.79	0.58	Strongly Agree
81.	Navigate to select clear fault codes	4.87	0.37	Strongly Agree
82.	Carrying out clearing fault will be displayed	4.85	0.65	Strongly Agree
83.	No fault found will be displayed after clearing of fault	3.61	1.34	Agree

The data presented in Table 3 revealed that, of the 27 items on lighting maintenance, 20 items whose mean responses are above 3.50 – 5.00 on a 5 point scale were considered strongly agree. While items 148, 149, 150, 151, 152,153 and 173 with mean responses of 4.50, 4.49, 4.37, 4.39, 4.39, 4.45 and 3.61 respectively were considered agree. It therefore shows that the respondents agree with all the items. The standard deviation (SD) of the items ranged from 0.32 to 1.34, this indicate that the respondents are close in their rating.

### Research Question 3

What teaching strategies are required for automobile starting and lighting system training manual?

**Table 3**

### Mean and Standard Deviation of Respondents on Teaching Strategies Required for Automobile Starting and Lighting System Training Manual N = 105

	Strategies	Mean	SD	Remark
84	Carrying out demonstration in all practical activities involved in starting and lighting system maintenance	3.30	1.00	Required
85	Employing learning and doing in teaching concept of starting and lighting system	3.56	0.87	Highly Required
86	Field trip/excursion to see well established auto-electricity/electronics industries and workshops	3.60	0.80	Highly Required
87	Using discussion method in teaching the learner starting and lighting system	3.28	0.93	Required
88	Employing modeling in teaching various aspects of starting and lighting system to enable the learner to imitate	3.83	0.38	Highly Required
89	Role play to show steps in various aspects of starting and lighting system	3.56	0.59	Highly Required
90	Employing simulations in starting and lighting system in teaching the learners	3.70	0.48	Highly Required
91	Asking probing questions for teaching starting and lighting system	3.57	0.53	Highly Required
92	Encouraging students on workshop practice	3.48	0.68	Required
93	Applying guided observation in practical lesson	3.44	0.65	Required
94	Using discovery method in training of students in starting and lighting system	3.56	0.65	Highly Required
95	Learning by imitation enhance the students to learn all aspect of auto-electricity/electronics	3.39	0.75	Required
96	Applying programmed learning in teaching starting and lighting system to the student	3.10	0.73	Required
97	Encouraging individualized instructions in auto-electricity/electronics for slow learners	3.36	0.68	Required
98	Involving and encouraging group discussion in small groups to ensure student participation in starting and lighting system maintenance practice	3.23	0.71	Required
99	Use of video, tape, television, and other technological devices in teaching concepts starting and lighting system	3.50	0.64	Highly Required
100	Giving assignment to students on starting and lighting system	3.52	0.76	Highly Required
101	Employing lecture method in teaching some aspect of starting and lighting system	3.46	0.78	Required
102	Using jigsaw method in teaching the learner starting and lighting system	3.05	0.79	Required
103	Mentoring students in carrying out real life practical for teaching all steps involved in starting and lighting system	3.10	0.78	Required
104	Using modern equipment, replica of what the learner will meet in real life situation in teaching starting and lighting system	3.11	0.82	Required
105	Involving auto-electricity/electronics experts in teaching some specialize areas of starting and lighting system	3.18	0.93	Required

106	Employing coaching in teaching various steps in starting and lighting system maintenance	3.16	0.91	Required
107	Using concept of mapping in teaching all aspect of starting and lighting system	3.17	0.98	Required
108	Developing computer assisted instructions on some aspects of starting and lighting system	3.14	0.84	Required
109	Always apply surveying technique to students to ask questions during classes	3.12	0.90	Required
110	Involving students in selection of suitable tools and materials for every practical to be taught in starting and lighting system	3.15	0.89	Required
111	Always explaining various aspects of starting and lighting system to the learner for more understanding	3.17	0.99	Required

The data presented in Table 3 revealed that, of the 28 items on teaching strategies, only 9 items whose mean responses are above 3.50 – 4.00 on a 4 point scale were considered highly required. 19 items with mean responses of 2.50 – 3.49 were considered required by the respondents. It therefore shows that the respondents agree with all the items on teaching strategies. The standard deviation (SD) of the items ranged from 0.38 to 1.00, implying that the respondents were very close in their rating.

#### Research Question 4

What training materials are required for automobile starting and lighting system training manual?

#### Table 4

#### Mean and Standard Deviation of Respondents on training Materials Required for Automobile Starting and Lighting System Training Manual N = 105

	Materials	Mean	SD	Remark
112	Hammer (Assorted)	3.15	0.94	Required
113	Pliers	3.30	0.77	Required
114	Long nose pliers	3.27	0.84	Required
115	Grapping pliers	3.24	0.81	Required
116	Rubber mallet	3.41	0.73	Required
117	Files (Assorted)	3.41	0.65	Required
118	G-clamp	3.19	0.82	Required
119	Punch	3.14	0.92	Required
120	Wire brush	3.43	0.73	Required
121	Testing lamp	3.23	0.82	Required
122	Ammeter	3.41	0.74	Required
123	Voltmeter	3.36	0.75	Required
124	Grease gum	3.28	0.87	Required
125	Set of chisels	3.40	0.74	Required
126	Socket spanners	3.33	0.87	Required
127	Open ended spanners	3.27	0.85	Required
128	Ring spanners	3.52	0.67	Required
129	Allen keys	3.44	0.68	Required
130	Set of screwdrivers	3.31	0.86	Required
131	Gloves	3.32	0.80	Required
132	Engine oil	3.31	0.85	Required
133	Bench vice	3.25	0.92	Required
134	Work bench	3.18	1.02	Required
135	Cables (wire)	3.25	0.85	Required
136	Oil can	3.27	0.90	Required
137	Aprons	3.20	0.93	Required
138	Portable drilling machine	3.22	0.90	Required
139	Hacksaw frame and blade	1.69	0.89	Required
140	Hand vice	1.69	0.91	Moderately Required
141	Hand drill	1.67	0.85	Moderately Required
142	Wire brush	2.97	1.14	Moderately Required
143	Sand paper	2.96	1.06	Required
144	Dwell meter	3.06	1.09	Required
145	Oscilloscope	3.06	1.02	Required
146	Electrical soldering iron	3.02	1.07	Required
147	Solder	3.10	0.97	Required



148	Battery charger	3.15	0.98	Required
149	Goggle	2.95	1.01	Required
150	Electrolyte	2.97	1.08	Required
151	Scan tool	3.03	1.07	Required
152	Computer interface	3.05	0.96	Required
153	Computer	2.93	1.10	Required
154	OBD connector	3.27	0.82	Required
155	Computer software	3.09	0.94	Required

The data presented in Table 4 show that, of the 44 items on training materials, 41 items whose mean responses are above 2.50 – 3.49 at 4 point scale were considered required. While items 28, 29 and 30 with mean responses of 1.69, 1.69 and 1.67, respectively were considered moderately required. The standard deviation (SD) of the items ranged from 0.65 to 1.14, this imply that the respondents were close in their rating.

### Research Question 5

What evaluation criteria are required for automobile starting and lighting system training manual?

**Table 5**

### Mean and Standard Deviation of Respondents on Evaluation Criteria Required for Automobile Starting and Lighting System Training Manual N = 105

	Evaluation	Mean	SD	Remark
156	Quality of work and maintenance in starting and lighting system	3.15	1.02	Required
157	Selection of right tools and equipment	3.18	0.90	Required
158	Application of technical knowledge and skill in starting and lighting system	3.57	0.72	Highly Required
159	Ability to adopt required skills in new situation	3.59	0.83	Highly Required
160	Creativity in starting and lighting system maintenance	1.42	0.73	Not Required
161	Effective use of tools and materials	3.59	0.65	Highly Required
162	Acceptance and application of advices and correction in starting and lighting system	1.38	0.67	Not Required
163	Quality of finished work	3.82	0.39	Highly Required
164	Efficient management of time in starting and lighting system maintenance	3.84	0.37	Highly Required
165	Sustainability of the steps adopted in auto-electricity/electronics maintenance	3.86	0.35	Highly Required
166	Problem solving ability in the face of new challenges	3.81	0.39	Highly Required
167	Ability to adapt to correct learnt skills to new situation	3.65	0.66	Highly Required
168	Failure to follow procedures as initially planned	3.87	0.34	Highly Required
169	Commitment through regular attendance to practical classes in starting and lighting system	3.60	0.85	Highly Required
170	Carefulness in handling maintenance	3.10	1.15	Required
171	Aesthetic value of finished work	3.29	1.08	Required
172	Workability of finished work	3.13	1.23	Required

The data presented in Table 5 indicates that, out of the 17 items on evaluation, 10 items whose mean responses are between 3.50 – 4.00 at 4 point scale were considered highly required. While items 1, 2, 15, 16 and 17 whose mean responses of 2.50 – 3.49 were considered required. However, items 5 and 7 whose mean responses are between 0.50 – 1.49 were scores low by the respondents. The standard deviation (SD) of the items ranged from 0.34 to 1.23, implying that the respondents were very close in their rating.

### Research Question 6

How effective is the developed automobile lighting system training manual?

Data collected to provide answer to research question 6 are presented in Table 6.

**Table 6**

### Effectiveness of the Developed Automobile Lighting System Training Manual

Group		Pre-test	Posttest	Mean Gain
Experimental	N	25	25	
	Mean	18.80	66.48	47.68
	Std. Deviation	6.06	8.64	
Control	N	30	30	
	Mean	18.47	24.43	5.97
	Std. Deviation	4.81	6.77	

The data in Table 6 compare the mean scores of both the experimental and control groups before and after teaching. The table reveals that, the experimental group had a mean score of 18.80 in the pre-test and rose to 66.48 with a mean gain of 47.68 after the interaction with the package, while the control group had a mean score of 18.47 in the pre-test and rose to 24.43 in the post-test with a mean gain of 5.97. This is an indication that, there is a significant effect of the use of automobile lighting system maintenance training manual on student's practical skills and knowledge acquisition. This is implying that the manual is effective.

### Hypothesis

There is no significant difference between the performances of students taught with the developed manual and those taught without the developed manual.

Data collected to test this hypothesis are presented in table 10.

**Table 7**

### Ho. Summary of ANCOVA on the Performances of Students Taught with the Developed Manual and those Taught without Manual.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	408.489	2	204.244	3.837	.028
Intercept	13226.106	1	13226.106	248.446	.000
Pretest	351.368	1	351.368	6.600	.013
Group	48.562	1	48.562	.912*	.044
Error	2768.238	52	53.235		
Total	238159.000	55			
Corrected Total	3176.727	54			

\*Significant at sig of  $F < 0.05$

The data presented in Table 7 show the F-calculated for mean scores of the experimental and control groups in the mean performance in the use of auto-electricity/electronics training manual. The F-calculated value for the group is 0.912 with a significance of F at 0.044, which is less than 0.05, hence the null hypothesis is not accepted at 0.05 level of significance.

### Discussion

The data presented in Table 1 provided answer to research question one. The finding revealed that 9 out of the 11 items on the objective of starting and lighting system training manual were scored agreed by the respondents and found suitable for the manual. This finding is in line with the opinion of Mohammed (2008) that for effective skills acquisition in auto-mechanics the use of diagnostic tools and relevant facilities and equipment should be emphasized to increase student's practical knowledge and Donkor (2010) who stated that, defining goals and objectives serve as the foundation for the development of any activity.

The data presented in Table 2 provided answer to research question two. The finding revealed that 52 out of the 53 items on battery maintenance were agreed by the respondents as suitable for inclusion in the manual. This finding is in agreement with Femi and Abdulkadir (2011) who opine that battery terminals are still a little prone to corrosion and

hence the usual service of cleaning with water and applying jelly grease is still recommended. Also data in Table 3 revealed that the respondents agreed with all the 48 items on charging maintenance as relevant to be included in the manual. This finding is in line with Denton (2004) who stipulated the procedure for charging maintenance to include loosen battery terminals; loosen the alternator clips to removing the alternator, dismantling it and rectifying the fault.

Data in Table 3 answer research question three. This table revealed that, all the 28 items on teaching strategies are considered agree and suitable for inclusion in the manual by the respondents. The findings of this study is in agreement with Umar and Ma'aji (2011) who reported that potentials of students are developed with the use of different teaching strategies such as demonstration, simulation, role play among others for manipulation of workshop tools, equipment. Data presented in Table 4 answer research question four. The data implies that, all the 44 items on tools and equipment were required for inclusion in the starting and lighting system maintenance training manual as agreed by the respondents. In line with the findings of this study, Robert (2012) stated that facilities help trainers to translate abstract ideas to concrete ideas.

Data presented in Table 5 answer research question five. Table 5 reveals that, out of 17 evaluation criteria 15 were considered required for the starting and lighting system maintenance training manual by the respondents. The finding of this study is in agreement with Wondo (2004) who stated that practical work by students should be evaluated from the selection of tools and equipment to how the finished. It therefore implies that evaluation of practical skills should be a systematic process. Training manual evaluation can be formative or summative; this is aimed at helping to improve training during and at the end of the programme.

### **Conclusion**

Data obtained in this study indicate that the starting and lighting system maintenance training manual is a valid and reliable manual that could be used by technical college students and individuals to increase their knowledge and skills performance in diagnosing faults and repairs in automobiles. This implies that, when students were taught using training manuals, their performance is enhanced. This could be owing to the fact that, the training manual is handy, which they make reference to at their own convenience and pace. Employing these findings, the developed training manual for teaching and learning of starting and lighting system maintenance in the technical colleges helps in skills development, acquisition and retention.

### **Recommendations**

Based on the findings of this study, the following recommendations are made:

1. To stimulate meaningful understanding and skills acquisition, students and teacher should adopt the use of training manuals in training, especially in technical areas, where competency-based learning is expected.
2. Though, students should be encouraged to read and practice, group activities tend to favor skills oriented activities rather than individual practice.
3. The Federal Ministry of Education, through the supervisory agency, NBTE should organize workshops, inviting specialists and students to develop training manuals in all skills requiring courses for technical courses.
4. Since education is a life-long skills demand, the Federal Government should as matter of priority, provide the technical colleges with adequate tools, facilities and

fund for the consumables, to encourage skills acquisition, thus achieving the objectives their establishment.

5. Workshops, seminars and conferences should be organized for the technical college teachers to enlighten them on the importance and use of training manuals, either in print or electronics in facilitating skills acquisition.
6. Training Manuals should be used for all skills oriented training in the technical colleges, so that the objective could be achieved.

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