

DEVELOPMENT OF SELF-INSTRUCTIONAL MANUAL FOR MAINTENANCE OF MICROWAVE OVENS FOR ELECTRICAL CRAFTSMEN IN BENUE STATE

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Abstract: The study developed a self-instructional manual for maintenance of microwave oven for electrical craftsmen in Benue state. Specifically, the study determined the objectives, content and facilities required for developing a self-instructional manual for maintenance of microwave oven. Three research questions and three null hypotheses guided the study. The study adopted Sequential Exploratory Research Design, and was carried out in Benue State. A total of 96 respondents consisting of 44 lecturers/instructors and 51 electrical/electronic trade teachers were used for the study. The instrument used for data collection was: Microwave Oven Maintenance Self-Instructional Manual Questionnaire (MOMSIMQ). The instrument was face and content validated by three experts. The reliability of MOMSIMQ was found to be 0.86 using Cronbach Alpha formula. The data collected was analysed using mean, standard deviation and z-test. Findings of the study were as follows: 13 objectives were agreed to be suitable for development of microwave oven maintenance manual with a grand mean of $\bar{X} = 4.43$; 12 content items were agreed to be suitable for development of the microwave oven maintenance manual with grand mean of $\bar{X} = 4.40$ and 22 facilities were agreed to be suitable for maintenance of microwave ovens with a grand mean of $\bar{X} = 4.27$ among others. Based on the findings it was recommended among others that bodies responsible for development of curriculum for technical colleges such as National Board for Technical Education (NBTE) should use the objectives of the SIM to update the curriculum of electrical and electronic trade courses so as to equip the students with skills for effective maintenance and repair of microwave ovens.

Keywords: Self-Instructional Manual, Maintenance, Microwave Oven, Electrical Craftsmen.

Introduction

Technical colleges (TCs) are post-basic institutions, offering skill acquisition programmes that prepare students for specific trades or career. Its goals as emphasized by the national policy on education is to provide technical knowledge and skills necessary for economic and industrial development of the country and give training that will result to the production of skilled personnel who will be enterprising and self-reliant. Several factors such as poor funding, advancement in technology among others affects the efficiency of TCs in Nigeria (Onwasa, 2021). However, to achieve the goals of TCs, National Board for Technical Education (NBTE) has approved the following course clusters to be offered in technical colleges: Automobile trades, Agricultural trades, computer trades, building and woodwork trades, electrical/electronic trades amongst others (NBTE, 2019).

Electrical/electronic trade is a cluster of subjects offered in the technical college. The course produce craftsmen and other skilled personnel who will be enterprising and self-reliant with skills in basic electricity, maintenance, domestic and industrial installation, winding of electrical machines, as well as electronic repair among others (Shodeinde & Yisa, 2019). Hence, it is expected that graduates of this programme are equipped with the skills of repairing and servicing all kinds of electrical and electronic appliances. An electrical craftsman therefore is a graduate of a technical college who can conveniently repair or maintain all kinds of electronics. Some of which are radio, television, DVD player, refrigerator, microwave ovens to mention a few.

A microwave oven is a kitchen appliance that heats and cooks food by passing electromagnetic radiations through the food. These radiations are within the frequency range of microwaves (Khan, 2018). Just like any other electrical appliance when not maintained properly the microwave can develop faults. Hence, regular maintenance of microwave ovens is highly recommended.

Maintenance is a process carried out periodically to maintain good working condition of an appliance (Sivakumar, 2022). This involves series of steps peculiar to the fault and appliance, normally carried out by technical personnel. However, a booklet containing such steps to guide the maintenance process for an appliance is known as a maintenance manual. A self-instructional maintenance manual therefore is a document containing step-by-step instruction that will guide craftsmen on how to maintain microwave ovens even without an instructor. The process of developing such a document requires identification of content, listing the facilities required and stating clear objectives.

Objectives are simply statements that describe the expected outcome. According to Johnson *et al.* (2021), objectives which are sometimes called aims, goals or success criteria, are explicit statements that describe what a person is expected to do as a result of following certain instructions. These objectives in most instances are the bases for development of contents. Content is simply the total knowledge and skills provided to a person about a concept. It is an element that plays very crucial role in achieving the goals and objectives of a skill acquisition process. Technical skills along adequate facilities ensure effective performance of tasks. Facilities for maintenance are resources that enhance an effective repair, service or replacement of damaged parts of an appliance. According to Adigeb *et al.* (2017), facilities can be defined as the buildings as well as items such as machines, laboratory equipment and tools used for learning. Adequate facilities are of immense benefit to a skillful craftsman in carrying out practical task, such as the ones complied in a maintenance manual.

Development of a self-instructional manual for maintenance of microwave ovens will help provide the skills needed by electrical and electronic craftsmen to effectively maintain the appliance. Considering that electrical and electronic craftsmen who are graduates of TCs do not possess the required skills to effectively maintain microwave ovens. Hence, developing a self-instructional manual for maintenance of microwave ovens would benefit electrical craftsmen especially in Benue State.

Statement of the Problem

Technical colleges (TCs) have the main goal of supplying competent craftsmen into the labour market. To effectively achieve this, its curriculum is periodically reviewed to accommodate changes in the work environment such as advancement in technology. This advancement has brought about invention of several electrical appliances such as microwave ovens. Technical colleges have not been able to keep up with the advancement in technology, therefore creating a gap between skills acquired by craftsmen and the skills needed in the labour market.

Consequently, graduates of technical colleges (electrical craftsmen) are seen roaming the streets with no use for themselves and their immediate society, therefore resulting to depression and temptation to engage in all kinds of social vices (Yustus *et al.*, 2021). Technology will keep advancing and one ways of making-up for the inefficiencies of TCs is to develop training modules or self-instructional manuals such as the one intended by the research to argument the efforts of TCs.

Purpose of the Study

The study aimed at developing a self-instructional manual for maintenance of microwave oven for electrical craftsmen in Benue State. Specifically, the study achieved the following objectives:

1. Determined the objectives of the self-instructional manual for maintenance of microwave oven.
2. Determined the contents of the self-instructional manual for maintenance of microwave oven.
3. Identified facilities required for carrying out tasks in the self-instructional manual for maintenance of microwave oven.

Research Questions

The following research questions guided the study:

1. What are the objectives of the self-instructional manual for maintenance of microwave oven?
2. What are the contents of the self-instructional manual for maintenance of microwave oven?
3. What are the facilities required for carrying out tasks in the self-instructional manual for maintenance of microwave oven?

Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance:

- H₀₁:** There is no significant difference between the mean response of electrical/electronic engineering technology lecturers in polytechnics and electrical/electronic trade teachers in technical colleges on the objectives of the self-instructional manual for maintenance of microwave oven.
- H₀₂:** There is no significant difference between the mean response of electrical/electronic engineering technology lecturers in polytechnics and electrical/electronic trade teachers in technical colleges on the contents of the self-instructional manual for maintenance of microwave oven.
- H₀₃:** There is no significant difference between the mean response of electrical/electronic engineering technology lecturers in polytechnics and electrical/electronic trade teachers in technical colleges on the facilities required for carrying out tasks in the self-instructional manual for maintenance of microwave oven.

Methodology

A mixed method research design known as sequential exploratory research design was adopted for the study. The study was carried out in Benue state, Nigeria. The targeted population for this study was 96 respondents. This consists of 44 electrical/electronic technology engineering lecturers/instructors in polytechnics and 51 technical college teachers teaching electrical/electronic trades in TCs. The instrument used for data collection was a structured questionnaire titled "Microwave Oven Maintenance Self-Instructional Manual Questionnaire" (MOMSIMQ). The instrument was face and content validated by three experts. It was pilot tested on 10 respondents in Niger State. The coefficient of internal consistency of the instrument was calculated using Cronbach's Alpha and found to be: 0.86, 0.84 and 0.88 for sections A, B and C respectively and the overall reliability index obtained was 0.86. The instrument was administered by the researcher with the aid of three research assistants. Statistical mean and standard deviation was used to answer research questions 1, 2 and 3 while Z-test was used to test null hypothesis 1, 2 and 3, at a significance level of 0.05.

Results

Table 1: Mean and Standard Deviation of Respondents on the Objectives of a Self-Instructional Manual for Maintenance of Microwave Oven

S/N	ITEMS	Mean (\bar{X})	SD	Remarks
1.	Identify functions of basic components in a microwave oven.	4.29	0.93	A
2.	Develop safety skills for maintenance of microwave ovens	4.47	0.66	A
3.	Identify the steps of troubleshooting a microwave oven.	4.43	0.52	A
4.	Identify the steps in replacing a damaged component in a microwave oven	4.12	0.85	A
5.	Identify the common faults in a microwave oven	4.64	0.55	SA
6.	Identify steps in servicing a microwave oven not powering on	4.60	0.59	SA
7.	Identify steps in servicing microwave oven not heating	4.67	0.49	SA
8.	Repair microwave oven that always stops in the middle of cooking	4.46	0.74	A
9.	Repair microwave oven door not closing properly	4.68	0.56	SA
10.	Identify steps in servicing microwave oven touch pad/button	4.25	0.64	A
11.	Identify steps on how to service microwave oven that is making unusual noise.	4.45	0.79	A
12.	Describe how to repair microwave oven light	4.33	0.59	A
13.	Identify steps in servicing microwave oven that won't off from power button or when door opens.	4.24	0.50	A
Grand Total Mean/SD		4.43	0.56	A

Key: SA = Strongly Agree, A= Agree, SD = Standard Deviation, \bar{X} = Mean

The analysis in Table1 revealed the mean responses of respondents on the objectives of the self-instructional manual for maintenance of microwave oven ranging from 4.12 to 4.68 and a grand mean of 4.43 which shows that the respondents jointly agree with the objectives of the self-instructional manual. Similarly, the standard deviation obtained ranged from 0.49 to 0.93 which further indicates the responses were not too far from the mean and were also close to one another. This closeness of the responses adds value to the reliability of the mean. Hence, the objectives are suitable for a self-instructional manual for the maintenance of microwave oven.

Table 2: Mean and Standard Deviation of Respondents on the Content of the Self-Instructional Manual for Maintenance of Microwave Oven

S/N	ITEMS	Mean (\bar{X})	SD	Remark
1	Basic components of a microwave and functions	4.51	0.52	SA
2	Safety skills for maintenance microwave oven	4.64	0.72	SA
3	Steps for troubleshooting microwave oven	4.21	0.83	A
4	Steps in replacing damaged components of a microwave oven	4.18	0.48	A
5	How to repair microwave oven that is not powering on	4.02	0.58	A
6	How to service microwave oven not heating	4.72	0.71	SA
7	How to repair oven which offs during cooking	4.62	0.82	SA
8	How to repair microwave oven door not closing properly	4.43	0.95	A
9	How to service microwave oven touch pad/botton	4.31	0.55	A
10	How to service microwave oven that is making unusual noise	4.73	0.64	SA
11	How to repair microwave oven light	4.12	0.65	A
12	How to repair microwave oven that won't stop working	4.33	0.81	A
Grand Mean/SD		4.40	0.69	

Key: SA = Strongly Agree, A= Agree, SD = Standard Deviation, \bar{X} = Mean

The analysis in Table 2 revealed the mean responses of respondents on the content of the self-instructional manual for maintenance of microwave oven ranging from 4.02 to 4.73 and a grand mean of 4.40 which shows that the respondents jointly agree with the content of the self-instructional manual. Furthermore, the standard deviation obtained ranged from 0.48 to 0.95 which buttressed the fact that the respondents were close to one another in their responses. This closeness of the responses adds value to the reliability of the mean. Hence, the contents are suitable for a self-instructional manual for the maintenance of microwave oven.

Table 3: Mean and Standard Deviation of Respondents on the Facilities Required for Practical Work and Utilization of the Self-Instructional Manual for Maintenance of Microwave Oven

S/N	ITEMS	Mean (\bar{X})	SD	Remarks
1	A conducive, well illuminated and equipped work environment.	3.87	0.69	R
2	A set of screw drivers.	4.82	0.41	HR
3	Putty knife/slot screw driver	4.81	0.39	HR
4	Diagonal pliers	3.57	0.92	R
5	Long nose pliers	3.58	1.12	R
6	Wrench (5mm)	3.64	1.12	R
7	Spanners/ nut drivers	4.58	0.52	HR
8	Adjustable wrench	4.29	0.80	R
9	Electrical Tester	4.27	0.70	R
10	Soldering Iron (small-tipped 30-to-50 watt irons)	4.68	0.56	HR
11	Soldering lead and paste for soldering	4.65	0.60	HR
12	Vinyl insulation tape	4.58	0.58	HR
13	Polishing cloth	3.48	0.99	MR
14	Safety wear (Aprons, gloves etc)	4.31	0.85	R
15	Brush for cleaning dusty parts	4.57	0.59	HR
16	A standard Multi-meter Tester.	4.85	0.39	HR
17	Microwave survey meter (Holaday HI-1500; HI-1501) and (Narda 8100; 8200).	4.68	0.59	HR
18	Glass thermometer: 100°C or 212°F	4.29	0.60	R
19	Methylated spirit	4.68	0.54	HR
20	A desk lamp and magnifying glass for critical observation of little components.	3.75	1.11	R
21	User manual containing guidelines on how to operate and clean the microwave oven.	3.27	1.14	MR
22	Electricity supply sources (AC and DC supply)	4.82	0.41	HR
Grand Mean/SD		4.27	0.67	

Key: HR = Highly Required, R = Required, MR = Moderately Required, SD = Standard Deviation, \bar{X} = Mean

The analysis in Table 3 revealed the mean of responses from the respondents on facilities required for carrying out task in the self-instructional manual for maintenance of microwave oven. The mean ranged from 3.18 to 4.85 and a grand mean of 4.27 which shows that the respondent's unanimously agreed on the facilities required to effectively use the self-instructional manual. Furthermore, the standard deviation obtained ranged from 0.39 to 1.14 which indicates that the respondents were close to one another and also with the mean in their responses. This closeness of responses increases the reliability of the mean. Hence, it implies that the facilities are required for a self-instructional manual for the maintenance of microwave oven.

Table 4: Z-Test Analysis of Mean Response of Electrical/Electronic Engineering Technology Lecturers in Polytechnics and Electrical/Electronic Trade Teachers in Technical Colleges on the Objectives of the Self-Instructional Manual for Maintenance of Microwave Oven

Objectives		Leven's Test for Equality of Variance		Z-test for Equality of Means						
		F	Sig.	Z	df	Sig. (2-tailed)	Mean diff.	Std. error diff.	95% interval of the difference	
									Lower	Upper
Objectives	Equal variance assumed.	.764	.674	1.45	84	.129	4.538	3.936	-1.784	4.39
	Equal variance not assumed.			1.94	54.93	.056	4.538	3.136	-.243	3.45

The Z-test analysis shown in table 4 reveals that there is no significant difference between the mean response of lecturers and technical college teachers on the objectives of the SIM for maintenance of microwave ovens. The Leven's Test shows a p-value of 0.67 which means there is equal variances. Furthermore, the Z- test value for the analysis was 1.45 and a p-value of 0.129 which is greater than the bench mark of 0.05 was obtained, implying that there is no significant difference. Hence the null hypothesis was accepted.

Table 5: Z-Test Analysis of Mean Response of Electrical/Electronic Engineering Technology Lecturers in Polytechnics and Electrical/Electronic Trade Teachers in Technical Colleges on the Contents of the Self-Instructional Manual for Maintenance of Microwave Oven

Content		Leven's Test for Equality of Variance		Z-test for Equality of Means						
		F	Sig.	Z	df	Sig. (2-tailed)	Mean diff.	Std. error diff.	95% Interval of the Difference	
									Lower	Upper
Content	Equal variance assumed	3.412	.217	0.12	85	.723	4.518	0.916	-0.814	1.59
	Equal variance not assumed			0.11	12.43	.723	4.510	0.915	-1.041	1.49

The Z-test analysis on Table 5 shows that there is no significant difference between the mean response of lecturers and technical college teachers on the objectives of the manual. Leven's Test was carried out to determine if there was equal variances, results as shown in Table 5 confirmed the presence of equal variance with a p-value of 0.217. However, the Z- test value for the analysis

was 0.12 and a p-value of 0.723 was obtained which is higher than the bench mark of 0.05, implying that the difference in responses between the two groups of respondents was not significant. Hence hypothesis two was accepted, because there was no significant difference.

Table 6: Z-Test Analysis of Mean Response of Electrical/Electronic Engineering Technology Lecturers in Polytechnics and Electrical/Electronic Trade Teachers in Technical Colleges on the Facilities Required for Carrying out Tasks in the Self-Instructional Manual for Maintenance of Microwave Oven.

		Leven's Test for Equality of Variance		Z-test for Equality of Means						
		F	Sig.	Z	df	Sig. (2-tailed)	Mean diff.	Std. error diff.	95% Interval of the Difference	
									Lower	Upper
Facilities	Equal variance assumed	4.54	.401	0.25	85	.619	5.036	2.406	-0.914	3.19
	Equal variance not assumed			0.26	20.03	.610	5.058	2.326	-0.923	3.25

The Z-test analysis on Table 6 shows that there is no significant difference between the mean responses of the two groups concerning facilities required for carrying out tasks in the manual. Leven's Test showed equal variance having a p-value of 0.401. However, the Z- test value from the analysis was 0.25 and a p-value of 0.619 was obtained which is higher than the bench mark of 0.05, indicating that the difference was not significant. Therefore, hypothesis three was accepted.

Discussion of Findings

Data presented in Table 1 highlights the objectives of SIM for maintenance of microwave oven as: identification of steps on troubleshooting, development of safety skills, replacing damaged components, repairing common faults, amongst others. Objectives such as repair of microwave oven not heating, not powering on, door not closing properly and identifying common faults had the highest means. However, the respondents agreed that all the objectives are suitable, hence it became the bases for development of SIM content. This is in agreement with a study carried out by Kalat *et al.* (2022), on reliability-based maintenance manual for training craftsmen on maintenance of injection stations. They asserted that clearly stated objectives are paramount to appropriateness of content selected which results to the success of any self-instructional material. Similarly, Ajunwa *et al.* (2018), also highlighted troubleshooting skills, safety precautions and repair of faults as objectives when developing a training manual for maintenance of Radio and Digital Versatile Disc player for electronics craftsmen. These further buttress the fact that the success of SIM for maintenance of microwave ovens was as a result of clearly stated objectives.

The analysis on Table 2 revealed content of SIM for maintenance of microwave oven to include: basic components of microwave oven, safety skills, steps for troubleshooting microwave ovens, how to repair common faults among others. All items which formed content of the manual were agreed by the respondents. In support of this finding is a study *carried out by* Ohanu *et al.* (2020), on maintenance practices required by electrical installation and maintenance work personnel for repairing industrial motors in Enugu State. They also stated that steps of troubleshooting, repairing of faults and precautionary measures are paramount in the maintenance of electrical appliances such as industrial motor.

Data presented on Table 3 shows the facilities required for carrying out tasks stated in the SIM for maintenance of microwave ovens. Such facilities includes: screwdrivers, multimeter, soldering iron, pliers, insulation tape, electricity supply source, thermometer among others. The availability

and functionality of these facilities is of immense importance to effective maintenance of microwave ovens. In support of the findings is a study carried out by Aliyu (2017), on development of instructional manual for teaching crafts in N.C.E Home Economics Programme in North-West Nigeria. He revealed that adequate resources and facilities are important in implementing instructional manuals aimed at improving skills of craftsmen. Similarly, Ajunwa *et al.* (2018), also attests to the fact that facilities such as multimeters, pliers, screwdrivers, soldering iron and lead among others are facilities used for maintenance of electrical appliances.

Data presented on Table 4 shows there is no significant difference between the mean response of lecturers in polytechnics and electrical/electronic trade teachers in technical colleges on the objectives of the SIM for maintenance of microwave oven. This was found irrespective of the difference in level of expertise and experience between and within the two groups of respondents. Therefore, this finding represents what should truly be the objectives of the SIM. This is in concordance with the findings of a study carried out by Shailong (2014), that there is no significant difference between the responds of lecturers and technical teachers on objectives of a SIM for tailoring. Furthermore, the finding buttresses the importance and suitability of the objectives for development of SIM for maintenance of microwave ovens.

Data presented on Table 5 shows there is no significant difference between the mean response of electrical/electronic lecturers in polytechnics and electrical/electronic trade teachers in technical colleges on the contents of the SIM for maintenance of microwave oven. It implies that the variation between the mean responses of the two groups of respondents was not high enough to reject the null hypothesis. The finding is in line with the findings of a study carried out by Iqbal *et al.* (2019), which states that there is no significant difference in the response of lecturers and teachers as regards the content of maintenance manual.

Data presented on Table 6 shows there is no significant difference between the mean response of polytechnic lecturers and electrical/electronic trade teachers on the facilities required for carrying out tasks in the SIM for maintenance of microwave oven. This means all respondents irrespective of the category agreed that the stated facilities are necessary to effectively carrying out tasks outlined in the SIM for maintenance of microwave ovens. Alome *et al.* (2023), supports this finding with the assertion that lecturers and electrical/electronic trade teachers agree on the fact that facilities are very crucial in carrying out maintenance tasks.

Conclusion

The study determined the objectives, contents and facilities that are relevant for the development of a self-instructional manual for maintenance of microwave ovens. This was used to develop an effective self-instructional manual for maintenance of microwave oven to be used by electrical/electronic craftsmen in Benue State. It was developed to improve skill performance and meet the needs of electrical/electronic craftsmen in the state.

Recommendations

Based on the findings of the study, the following recommendations were made;

1. Bodies responsible for development of curriculum for technical colleges such as National Board for Technical Education (NBTE) should use the objectives of the SIM to update the curriculum of electrical and electronic trade courses so as to equip the students with skills for effective maintenance and repair of microwave ovens.
2. Organizers of skill acquisition programmes such as Small and Medium Enterprise Development Agency of Nigeria (SMEDAN) should use the content of the SIM for maintenance of microwave ovens as a resource material when planning workshops on electronic repairs to train participants on effective ways of maintaining and repairing microwave ovens.
3. This manual is recommended for electrical appliances repair workshops especially in Benue state to serve as a guide on the facilities required for maintenance of microwave ovens or reference material during repair of microwave ovens and an instructional guide in training of apprentices.

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