COMPETENCIES FOR THE MAINTENANCE AND REPAIR OF AIR-CONDITIONERS AND REFRIGERATOR FOR SELF-EMPLOYMENT IN ENUGU METROPOLIS

Alio, A. N. (Ph.D) & Eze, Raymond A
Department of Technology and Vocational Education, Enugu State University of Science and Technology (ESUT) Enugu, **08100142742**

Abstract
The study investigated competencies for the maintenance and repair of air-conditioners and refrigerators for self-employment in Enugu metropolis. Three specific objectives were structured to guide the study. Accordingly, three research questions were posed in line with specific objectives and three hypotheses were tested. The study adopted descriptive survey research design. The population for the study was 31 which comprised of 21 males and 10 female technology teachers. There was no sampling because the population was manageable. Structured questionnaire was used for data collection. The instrument was validated by three experts; two from Technology and Vocational Education Department and one from Department of Computer and Mathematics Education, all from the Faculty of Education, Enugu State University of Science and Technology (ESUT), Enugu. A reliability co-efficient of 0.70 was obtained using cronbach alpha method. A total of 29 copies out of 31 copies of the instrument correctly filled and returned were used for the study, representing 93.5 percent return rate. Mean was used to answer the three research questions while the three null hypotheses were tested at 0.05 level of significance using t-test statistic. The result revealed that electrical/electronic technology education students require mechanical system, motor system and cooling system competencies for maintenance and repair of air-conditioners and refrigerator for self-employment in Enugu metropolis. It was recommended among others that government should endeavor to provide adequate workshop facilities that will enhance acquisition of practical skills in motor system, mechanical system and cooling system for air-conditioner and refrigerator maintenance for job creation and self-reliance.

Introduction

Learning is the process of acquisition of knowledge (practical and theoretical) which is one of the goals of education. According to Federal Republic of Nigeria (2013), one of the goals of education is the acquisition of appropriate skills and development of mental, physical, social abilities, competencies and as well the preparation for the individual to live and contribute to the development of his society. In Nigeria, technical education is the programme, given the mandate to produce craftsman or middle level manpower that will acquire practical skills in the utilization of technological devices through technical college (National Policy on Education, 2013).

Technical college is one of the institutions established by the Federal Government of Nigeria to provide individuals with practical skills, basic scientific knowledge and attitude that enable them to live successfully in the world. Technical colleges are institutions that provide secondary level of education in technical education (Ado & Hudu, 2018). According to Abassah (2019), technical college provides technical training in a number of courses which include general education, automobile trade, building and woodwork trade, business trade, computer trade, hospitality trade, mechanical trade, printing trade, textile trade, and electrical/electrical trade. Electrical/electronic trade is subdivided into television and electronics work, instrument mechanics and radio, air-conditioning and refrigeration maintenance and repairs works (FRN, 2013).

The technology of heat engine and refrigeration system has made living in a system habitual as a result of air conditioner system innovation. Air conditioner is an electro-mechanical device that moderates the temperature humidity and ventilation of a given system (room, car, shop, office) by the use of refrigerants or other coolants. Air conditioner (often referred to as AC) is an apparatus or machine that is used to control the temperature and humidity in an enclosed space (Hatten, 2017). The process of controlling the temperature and humidity is often regarded as air conditioning. Lawal (2020) posited that air conditioning is the process of removing heat from a confined space, thus cooling the air, and removing humidity. Basically, the function of air conditioner is to provide comfortable temperature, filtering and circulation the air in to the room. Air conditioning can be used in both domestic and commercial environments. This process is used to achieve a more comfortable interior environment, typically for humans or animals;

however, air conditioning is also used to cool/dehumidify rooms filled with heat-producing electronic devices, such as computer servers, power amplifiers, and even to display and store artwork.

Air-conditioners (AC) often use a fan to distribute the conditioned air to an occupied space such as a building or a car to improve thermal comfort and indoor air quality. According to Moore (2017), AC units range from small units that can cool a small bedroom, which can be carried by a single adult, to massive units installed on the roof of office towers that can cool an entire building. The cooling is typically achieved through a refrigeration cycle, but sometimes evaporation or free cooling is used. Air conditioning systems can also be made based on desiccants (chemicals which remove moisture from the air) and subterraneous pipes that can distribute the heated refrigerant to the ground for cooling (Alshayea, 2017).

Refrigeration is the process of removing heat from an enclosed space or from a substance for the purpose of lowering temperature. In refrigeration, there is a transfer of thermal energy from a place at a cold temperature to a place at a higher temperature (Peter, 2016). In air-condition, thermal heat energy is taken away to keep the air at a cool temperature. Therefore, air-condition is mainly for comfort in a room or enclosed spaced. Refrigerator, colloquially fridge is a commercial and home appliance consisting of a thermally insulated compartment and a heat pump (mechanical, electrical or chemical) that transfers heat from its inside to its external environment so that its inside is cooled to a temperature below the room temperature. Chiorlu, Ogundu and Obed (2016) stated that refrigerator is an essential food storage technique around the world. A refrigerator maintains a temperature a few degrees above the freezing point of water. It is a cooling system for food. Air-condition and refrigeration have compressor which forms the motor system and has the ability to suck, compress and discharge refrigerant in form of vapour to the condenser (Moore, 2017). The main components of window AC are packed in one box which is usually mounted on the window. The split air conditioner was invented due to the compressor noise which has annoying effects on the users of window air conditioner. The main components of window AC are split into two in this new design. These air conditioners are widely in use in both domestic and industrial sectors of the economy of Enugu State metropolis. These air conditioners utilized in dehumidifying the temperature of a given system usually demands maintenance for proper functionality (Abassah, 2019).

The need for the maintenance of AC has become pertinent because of the growing demand to achieve comfortable environmental conditions for human being. Maintenance is the art and act of retaining a machine or equipment in its working order. Maintenance takes place either in a functioning system to improve its performance or in broken down system to restore it to its functional condition(s). Lawal (2020) defined maintenance as any activity designed to keep equipment or other asset in good working conditions. Lawal stressed that very often; maintenance is associated with servicing equipment, replacing worn-out parts and doing emergency repairs. According to Ogbuanya (2019), maintenance involves all the actions/activities taken in order to prolong the service life of an item, machine or equipment. In essence, any activity aimed at keeping or restoring any utility to its satisfactory operating status can be considered a maintenance activity. The maintenance activity can only be done effectively based on competency.

Competency is the standard requirement for an individual to properly perform a specific job. Competency is the ability to possess suitable and sufficient skills, knowledge and experience for carrying out a particular task. Schoomaku (2015) noted that competency is the knowledge, skills, attitude and judgment which one requires in order to perform successfully at a specified proficiency in any given work. In the context of this study, competency is the capacity of a technical student to install, maintain and repair air-conditioner and refrigerator system. The competencies required for maintenance and repair of air-conditioner and refrigerator systems are competencies in motor system, mechanical system and cooling system competencies.

A motor is an electrical driven by an alternating current. The motor commonly consists of two basic parts, an outside stator having coils supplied with alternating current to produce a rotating magnetic output shaft producing a second rotating magnetic field. Air-conditioner and refrigerator motors use electrical current to produce rotating magnetic fields that in turn, generate mechanical force in the armature located on the rotor or stator around the shaft (Samson & Anthony, 2015). Air-conditioner and refrigerator have mechanical system.

Mechanical air-conditioning and refrigerator systems are the utilization of mechanical components arranged in air-conditioning and refrigerator systems for the purpose of transferring heat. The fridge has a small DC motor which operates the compressor which turns the refrigerant chemical into a liquid and keeps the appliance cold (Peter, 2016). The constant hum of the refrigerator shows that the motor is doing its job. Air-conditioner and refrigerator also have a cooling system.

Cooling system is a set of components that

enables the flow of liquid coolant to the passages in the engine block and head so as to absorb combustion heat. A cooling system transfers thermal energy in order to keep things cool. The thermal energy moves from a warmer area to a cooler area.

In practice, different types of maintenance competencies are used in keeping the life span of equipment. For anybody to assume the duty of serving as technology teacher, such a person is expected to possess adequate maintenance skills for imparting technical knowledge and skills, especially now that the emphasis is on competency-based learning. A technical teacher, according to Sullivan (2018), is an individual who is trained in the pedagogy and technical area of a particular subject to impart knowledge, skill and attitudes to students in an institution. Teachers of technology in this study are individuals who have been trained professionally in the art of teaching competencies in air-conditioning and refrigerator maintenance practice. A qualified technology teacher, whether male or female, should possess the required maintenance competency in order to keep the students abreast of maintenance practice. This is because acquisition of required maintenance competency will enable students to be self-employed upon graduation (Alshayea, 2017).

Self-employment refers to a situation where an individual creates, begins and takes control of the business decision rather than working for an employer. Abimbola (2016) described self-employment as act of working for oneself. Self-employment is the act of generating one's income directly from customers, clients or other organizations as opposed to being an employee of a business or person. When one is self-employed, it means one is carrying on one's own business rather than working for an employer (Ado & Hudu, 2018).

Maintenance in air-conditioner and refrigerator systems by craftsmen (graduates of technical colleges) involves acquisition of motor system, mechanical system and cooling system competencies but it is discouraging that these students are found on graduation jobless as a result of ignorance of the competencies which would propel them into the world of work and as well contributing to the development of the society at large. This shortfall negates the overall objectives of both the technical education as the graduates of technical colleges could be seen roaming the streets in search of white-collar jobs. Sullivan (2018) lamented that the training offered in technical colleges in Nigeria do not guarantee the success of graduates in their occupational areas. Equipping students with competencies in maintenance of air conditioners and refrigerator system will enable them to be self-employed. It is therefore worthwhile to identify competencies for the maintenance of air conditioners and refrigerator system for self-employment in Enugu metropolis.

Purpose of the Study

The main purpose of the study was to determine the competencies for the maintenance and repair of air-conditioners and refrigerator for self-employment in Enugu metropolis. Specifically, the study sought to:

1. determine the motor system competencies required for the maintenance and repair of air-conditioners and refrigerator for self-employment.
2. identify the mechanical system competencies required for the maintenance and repair of air-conditioners and refrigerator for self-employment
3. ascertain the cooling system competencies required for the maintenance and repair of air-conditioners and refrigerator for self-employment

Research Questions

The following research questions guided the study.

1. What are the motor system competencies required for the maintenance and repair of air-conditioners and refrigerator for self-employment?
2. What are the mechanical system competencies required for the maintenance and repair of air-conditioners and refrigerator for self-employment?
3. What are the cooling system competencies required for the maintenance and repair of air-conditioners and refrigerator for self-employment?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

Ho1: There is no significant difference in the mean ratings of male and female technology teachers on the motor system competencies required for maintenance and repair of air-conditioners and refrigerator.

Ho2: There is no significant difference in the mean ratings of male and female technology teachers on the mechanical system competencies required for maintenance and repair of air-conditioners and refrigerator.

Ho3: There is no significant difference in the mean ratings of male and female technology teachers on the cooling system competencies required for maintenance and repair of air-conditioners and refrigerator.

Methods

The study adopted a descriptive survey research design. The study was conducted in Enugu metropolis. The population for the study is 31 which comprised of 21 males and 10 female technology teachers. There was no sampling because the population was manageable. Structured questionnaire developed by the researchers was used for data collection. The instrument was validated by three experts; two from Technology and Vocational Education Department and one from measurement and Evaluation of the Department of Computer and Mathematics Education all from the Faculty of Education, Enugu State University of Science and Technology (ESUT), Enugu. The questionnaire used four-point rating scale with response options namely; Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). To determine the reliability of the instrument, the researchers administered 20 copies of the questionnaire to 20 technology teachers in technical colleges in Anambra State. Reliability co-efficient of 0.70 was obtained using Cronbach alpha method. A total of 29 copies out of 31 copies of the instrument correctly filled and returned were used for the study, representing 93.5 percent return rate. Mean was used to answer the three research questions. Any mean score of 2.50 and above was regarded as Agree while items with mean score below 2.50 were regarded as Disagree. The three null hypotheses were tested at 0.05 level of significance using t-test statistic. When the calculated t-value was equal to or greater than the critical value at appropriate degree of freedom, the null hypothesis was significant and rejected but when the t-calculated value was less than the critical value, the null hypothesis was not significant, and not rejected.

Results

Research Question 1: What are the motor system competencies required for maintenance and repair of air-conditioners and refrigerator?

Table 1: Mean Ratings of the respondents on the motor system competencies required for maintenance and repair of air-conditioners and refrigerator

S/N	**Motor system competencies**	**Male teachers**			**Female teachers**		
		$\overline{X}$	**SD**	**RMKS**	$\overline{X}$	**SD**	**RMKS**
1	Ability to identify a burntout motor coil	2.66	0.65	A	2.52	0.57	A
2	Ability to use measuring instrument	2.61	0.52	A	2.53	0.58	A
3	Ability to install correct protective equipment such as fuse and circuit breaker	2.68	0.88	A	3.44	0.69	A
4	Ability to dismantle the motor using correct tools and equipment	3.53	0.71	A	2.50	0.60	A
5	Ability to set the fan belt and pulley of the motor	3.39	0.51	A	2.51	0.57	A
6	Ability to change the motor gaskets	2.60	0.54	A	2.50	0.61	A
7	Ability to apply oil to the bearing and shafts with correct lubricants.	2.65	0.83	A	2.63	0.59	A
	Grand Mean	**2.87**	**0.66**	**A**	**2.66**	**0.60**	**A**

Data presented in Table 1 showed that the mean ratings of the respondents ranges from 2.50 to 3.44 which indicated that the respondents agreed that the aforementioned items are the motor system competencies required for maintenance and repair of air-conditioners and refrigerator for self-employment in Enugu metropolis.

Hypothesis 1: There is no significant difference in the mean ratings of male and female technology teachers on the motor system competencies required of students for maintenance and repair of air-conditioners and refrigerator.

Table 2: The t-test analysis of mean ratings of the respondents on the motor system competencies required of students for maintenance and repair of air-conditioners and refrigerator

Group	N	X	SD	df	t-cal	t-crit	Decision
Male teachers	21	2.94	0.66				Ho not rejected
Female teachers	10	2.76	0.60	29	1.29	1.96	

Data analyzed in Table 2 showed that the calculated t-value at 0.05 level of significance and 29 degree of freedom is 1.29, while the table value is 1.96. Therefore, the null hypothesis was not rejected. This implies that male and female technology teachers did not differ significantly in their opinions on the motor system competencies required for maintenance and repair of air-conditioners and refrigerator for self-employment in Enugu metropolis.

Research Question 2: What are the mechanical system competencies required for maintenance and repair of air-conditioners and refrigerator?

Table 3: Mean Ratings of the respondents on the mechanical system competencies required for maintenance and repair of air-conditioners and refrigerator

S/N	Mechanical system competencies	Male teachers			Female teachers		
		$\overline{X}$	SD	RMKS	$\overline{X}$	SD	RMKS
8	Ability to solder copper and iron pipes	3.00	0.65	A	2.52	0.57	A
9	Ability to select required horse-power compressor for a particular job	2.71	0.62	A	2.55	0.58	A
10	Ability to use manifold gauge to charge air-condition and refrigerator	2.68	0.88	A	2.57	0.60	A
11	Ability to cut copper pipes and braise/weld it	2.55	0.70	A	3.01	0.60	A
12	Ability to identify the area of leakage and diagnose it	3.11	0.52	A	2.58	0.59	A
13	Ability to dismantle and reassemble a reciprocating compressor	2.60	0.54	A	2.50	0.61	A
14	Ability to use oxygen acetylene gas set	2.70	0.83	A	2.71	0.59	A
	Grand Mean	**2.76**	**0.67**	**A**	**2.63**	**0.59**	**A**

Data presented in Table 2 revealed that the respondents agreed that the aforementioned items are mechanical system competencies required for maintenance and repair of air-conditioners and refrigerator for self-employment in Enugu metropolis. This is evidenced by the grand mean scores of 2.76 and 2.63

Hypothesis 2: There is no significant difference in the mean ratings of male and female technology teachers on the mechanical system competencies required of students for maintenance and repair of air-conditioners and refrigerator.

Table 4: The t-test analysis of mean ratings of the respondents on the mechanical system competencies required of students for maintenance and repair of air-conditioners and refrigerator

Group	N	X	SD	df	t-cal	t-crit	Decision
SME Managers	21	2.86	0.61				Ho not rejected
Business Educators	10	2.71	0.59	29	1.01	1.96	

Data analyzed in Table 4 showed that the calculated t-value at 0.05 level of significance and 29 degree of freedom is 1.01, while the table value is 1.96. Therefore, the null hypothesis was not rejected. This implies that male and female technology teachers had uniform opinions on the mechanical system competencies required of students for maintenance and repair of air-conditioners and refrigerator.

Research Question 3: What are the cooling system competencies required for maintenance and repair of air-conditioners and refrigerator?

Table 5: Mean Ratings of the respondents on the cooling system competencies required for maintenance and repair of air-conditioners and refrigerator

S/N	Cooling system competencies	Male teachers			Female teachers		
		$\bar{X}$	SD	RMKS	$\bar{X}$	SD	RMKS
15	Ability to remove air from a refrigerator and air-conditioning system	3.41	0.61	A	3.11	0.53	A
16	Ability to use manifold gauge to charge the system	3.53	0.72	A	3.40	0.50	A
17	Ability to locate the area of leak	3.49	0.63	A	3.06	0.46	A
18	Ability to select appropriate insulating material for a particular air-conditioner/refrigerator	3.53	0.53	A	3.15	0.48	A
19	Ability to use leak detector	3.26	0.69	A	3.37	0.59	A
20	Ability to select the appropriate refrigerant for the air-condition and refrigeration	3.51	0.50	A	3.30	0.56	A
	Grand Mean	**3.46**	**0.61**	**A**	**3.23**	**0.52**	**A**

Data presented in Table 5 revealed that the respondents agreed that the aforementioned items are cooling system competencies required for maintenance and repair of air-conditioners and refrigerator in Enugu State metropolis as indicated in grand mean scores of 3.46 and 3.23.

Hypothesis 3: There is no significant difference in the mean ratings of male and female technology teachers on the cooling system competencies required of students for maintenance and repair of air-conditioners and refrigerator.

Table 6: The t-test analysis of mean ratings of the respondents on the cooling system competencies required of students for maintenance and repair of air-conditioners and refrigerator

Group	N	X	SD	df	t-cal	t-crit	Decision
SME Managers	21	3.45	0.68				Ho not rejected
Business Educators	10	3.24	0.51	29	1.20	1.96	

Data analyzed in table 6 showed that the calculated t-value at 0.05 level of significance and 29 degree of freedom is 1.20, while the table value is 1.96. Therefore, the null hypothesis was not rejected. This implies that male and female technology teachers had similar views on the cooling system competencies required for maintenance and repair of air-conditioners and refrigerator.

Discussion of the Findings

The results of the analysis of research question one revealed motor system competencies required for maintenance and repair of air-conditioners and refrigerator for self-employment in Enugu metropolis. These competencies are ability to identify a burnt-out motor coil, ability to use measuring instrument, ability to install correct protective equipment such as fuse and circuit breaker, ability to dismantle the motor using correct tools and equipment, ability to set the fan belt and pulley of the motor and ability to apply oil to the bearing and shafts with correct lubricants. The findings are in consonance with that of Schoomaker (2015) who reported that acquisition of appropriate competencies required for maintenance and repair of air-conditioners and refrigerator is the prerequisite in the preparation of students for job creation and self-reliance. The corresponding hypothesis revealed that male and female technology teachers did not differ in their opinions on the motor system competencies required of students for maintenance and repair of air-conditioners and refrigerator. The result of the study depicts that gender has no influence on the responses of the respondents.

In addition, evidence from analysis of research question two showed that mechanical system competencies required for maintenance and repair of air-conditioners and refrigerator for self employment in Enugu metropolis. This finding is in line with Ogbuanya (2019) who noted that acquisition of installation and maintenance skills of air-conditioner and refrigerator as offered in technical colleges prepares an individual with job-satisfying requirements towards employment and self-reliance. This is in harmony with the findings of

Oluka and Onyebuenyi (2017) who stated that practical skills like ability to solder copper and iron pipes, ability to use manifold gauge to charge air-condition and refrigerator and ability to dismantle and reassemble a reciprocating compressors and likes are highly required for effective mechanical system maintenance and repair of air-conditioners and refrigerator for sustainable self employment of electrical/electronics technology education graduates. The corresponding hypothesis revealed that male and female technology teachers did not differ in their opinions on the mechanical system competencies required of students for maintenance and repair of air-conditioners and refrigerator. The implication is that gender has no influence on the responses to the itemized mechanical system competencies.

Data analyzed with regard to research question three indicated that electrical/electronic technology education students require cooling system competencies for maintenance and repair of air-conditioners and refrigerator for self employment in Enugu metropolis. The findings corroborate with that of Lawal (2020) who reported that technology teachers of technical colleges are poised with potentials of equipping the students with prerequisite skills in cooling system to propel them contribute meaningfully to national economic development, be self-reliant and job creators towards reduction of unemployment. The corresponding hypothesis revealed that male and female technology teachers had uniform opinions on the cooling system competencies required of students for maintenance and repair of air-conditioners and refrigerator for self employment in Enugu metropolis. The result of the study depicts that gender has no influence on the responses of the respondents.

Conclusions

Based on the findings made, the following conclusions were drawn. It can be concluded that electrical/electronic technology education students require mechanical system, motor system and cooling system competencies for maintenance and repair of air-conditioners and refrigerator for self-employment in Enugu metropolis. The study further revealed that male and female technology teachers had uniform opinions on the mechanical system, motor system and cooling system competencies required for maintenance and repair of air-conditioners and refrigerator for self-employment in Enugu metropolis.

Recommendations

The following recommendations were made in view of the findings of the study:

1. More attention and time allocation should be given to practical courses other than the theoretical counterparts.
2. Education policy makers and implementers should encourage and consider the use of environmental approach (industrial/workshop) to skill acquisition vital for professional development of students at technical colleges.
3. Government should endeavor to provide adequate workshop facilities that will enhance acquisition of practical skills in motor system, mechanical system and cooling system for air-conditioner and refrigerator maintenance for job creation and self reliance.
4. All the identified competencies should be integrated into the curriculum of technical colleges by curriculum planners for training of students.

References

Abassah, M. (2019). Analysis of the problems and prospects of the technical college teaches in Nigeria. *Proceedings of the 2020 International Conference on Teaching, Learning and Change by International Association for Teaching and learning* (IATEL), 097-702.

Abimbola, A. O. (2016). Skill improvement needs of technical teachers for maintenance of wood work equipment in secondary schools in Ogun State. Available at *http://www.com*,accessed 16/3/19

Ado, Y. & Hudu, I.M. (2018). Skill improvement needs of electrical teachers for maintenance of electrical laboratory equipment in technical olleges in kano State. *International Journal of Advanced Academic Research, Sciences, Technology and Engineering*, 4(7), 57-99

Alshayea, A. (2017). Dynanics of electrical laboratory maintenance. Available at *http://ksu.edu.sa/alshayea,* accessed 11/3/20.

Chiorlu, D.O; Ogundu, I, & Obed, O.O. (2016). Strategies for enhancing electrical students performance in domestic wiring in technical colleges in Rivers State Nigeria. *Journal of Research Science and Technology Education, 6, (1), 170-188*

Federal Republic of Nigeria (2013) *National policy on education*. Nigerian Educational Research and Development Council. (NERDC) Press, Lagos.

Hatten, T. S. (2017). *Air-conditioner and refrigerator maintenance skills*. South-Western Cengage Learning, USA.

Lawal, G. O. (2020). Maintenance culture: *the Nigeria situation. Journal of Engineering Management*. 1*(4),* 1-12

Moore, S. (2017). Define preventive maintenance. Available at *http://www.ehow.com,* accessed 25/3/20

Ogbuanya, T.C. (2019). *Energy and technology of home appliances*. Enugu: Cheston

Oluka, S. N. & Onyebuenyi, P. N. (2017). Electric motors maintenance practice training needs of electrical installation and maintenance works students for self-employment. *International Journal of Research,* 4 (13), 155-166.

Peter, O.E. (2016). *Electrical systems installation: practice and maintenance*. Ibadan: Lahan prints.

Samson, O. C. & Anthony, U. A. (2015). Corrective maintenance skills requirements in DVD home theatre for integration into technical college curriculum. *Journal of Problems of Education in the 21st century,* 66, 113-116

Schoomaker, P.J. (2015). *Technical manual, maintenance of electrical equipment practices*. Washington DC: Hurkson press

Sullivan, G. P. (2018). *Operations and maintenance best practice*. USA: Federal Energy Management propramme