CEDTECH International Journal of Educational Research & Human Development
Volume 1, Number 2, September 2020
http: / /www.cedtechjournals.org
ISSN: 2756-4592

SOLAR PHOTOVOLTAIC SKILLS REQUIRED FOR DEVELOPMENT OF ELECTRICAL AND ELECTRONIC TRADE TEACHERS IN SCIENCE AND TECHNICAL COLLEGES IN BENUE STATE.

[1]Iorbee, Michael Mlahaga *PhD*, [2]Atem, John Aondowase; [3]Ajon, Reuben Anyiishi,[4] Annongu, Hom Fabian
[1,2 3&4]Department of Vocational and Technical Education
Benue State University, Makurdi-Nigeria
Email: miorbee1966@gmail.com; atemjatem35@gmail.com
Corresponding author: Iorbee, Michael Mlahaga

ABSTRACT

The study determined "solar photovoltaic skills required for developing electrical and electronic trade teachers in science and technical colleges in Benue State" with a view of finding information that will help solve low level of solar photovoltaic installation and maintenance skills acquisition aimed at job creation. Two research questions guided the study while two null hypotheses were formulated. A descriptive survey research design was adopted with a population size of 100 and a purposive sample of 55 electrical and electronic trade teachers selected. A 29 item structured questionnaire instrument was developed by the researchers and validated by three experts from the Department Vocational and Technical Education, Benue State University, Makurdi and used for data collection. Data was analyzed using mean and standard deviation while t-test was used to test the hypotheses at 0.05 level of significance. The study found out that all the solar photovoltaic installation and maintenance skills identified were required to develop electrical and electronic trade teachers in science and technical colleges. The study also revealed a significant difference in the mean rating responses of technical college teachers who have worked for below five years and those above five years and attributed these differences to their learning experiences. It was recommended among others the inclusion of the identified skills in the technical college curriculum and the organization of frequent training courses and seminars for electrical and electronic trade teachers on solar photovoltaic installation and maintenance skills required to develop their competencies.

Keywords: *Solar Photovoltaic Skills, Electrical & Electronic Trade Teachers, Installation and Maintenance.*

INTRODUCTION

The twenty first century is bedeviled with emerging technologies whose skills acquisition poses challenges to both learners and their teachers who are expected to acquire these new skills in their institutions of learning to enable them perform well in their places of work. In Nigeria, one the institution that is responsible for the training of the skilled manpower for national development is the science and technical college. The mission of science and technical colleges in Nigeria is to provide students with practical skills in all trade subjects. This implies that science and technical college teachers themselves must be practically sound in their various trade related areas to be able to impart such skills to the learners. Iliya (2017) asserts that where technical teachers lack practical skills in employing instructional materials in learning situation, they provide the students with little chances for practical skills acquisition.

Medugu (2011) stated that 65 percent of skills seem to be lacking in Electrical and Electronic teachers of science and technical colleges in Nigeria with photovoltaic cell installation inclusive, judging by the inadequacy and poor performances of craftsmen in solar photovoltaic installation and maintenance work activities. Similarly, Jubrin, Okworo, Hassan, and Jatau, (2018) also agreed that one of the major problem affecting technical institutions in Nigeria is the production of unskilled technical personnel who cannot function effectively in the society. These authors further explained that, the production of unskilled technical personnel is due to lack of skills on the part of technical teachers or their weakness in imparting emerging practical skills of new technologies to learners during their school training session in the school workshop.

Today, the scramble for renewed energy applications call for new skills development in photovoltaic energy resource which has necessitated the desire for electrical and electronic teachers to develop and acquire necessary skills in photovoltaic installation and maintenance for effective teaching and learning process. Although, the National Board for Technical Education (NBTE) in Nigeria has been collaborating with Safe Energy Resources Kaduna to organized several workshops and seminars in order to train technical teachers, technicians, engineers and technologists in the area of solar photovoltaic technology skills acquisition; many teachers of science and technical colleges are still lacking in this essential twenty first century skills which is useful in all areas of technology in our society today.

Statistics on off grid solar photovoltaic installation in Nigeria stand at 34 percent, which is about nine million household (National Bureau of Statistic(NBS, 2017). This increasing electrification through solar energy requires practical training on the part of teachers and students alike to carry out new installations and subsequent maintenance of the existing ones. Solar Photovoltaic technology is a solid-state, semiconductor-based technology made up of solar panels that converts sunlight energy directly into electrical energy, without moving parts, noise, and emissions (Khalidin, &Sujod, 2010). A solar panel is an assembly of photovoltaic cells connected in series to achieve a desired output voltage and or in parallel to provide a desired current capability. The conducting wires which take the current off the panel may contain silver, copper or other non-magnetic conductive transition metals. Each panel output power is rated in direct current (dc) under standard test conditions and may range from 100 to 320 watts which can be used as a component of a large photovoltaic system to generate and supply electricity in commercial and residential applications (Ogbu, Afaor&Idoko, 2018).

There are currently various Solar cells products in the market and are classified based on the production material constituents, each with its advantages over others. Some of these popular solar cell products include among others; silicon cells, thin-film solar cells, Nanocrystal Solar Cells, Photo-electrochemical cells, Dye-sensitized hybrid solar cells and Polymer Solar cells. Silicon solar cells according to Ranabhat, Patrikeev, Revina, Andrianov, Lapshinsky and Sofronova, (2016) are the most efficient in terms of single cell photovoltaic devices. On the other hand, thin-film and nanocrystal solar cells potentially provide lower cost electricity than silicon crystalline solar cells of the voltage/current range.
The installation and continuous use of photovoltaic cells attract tear and wear which require various forms of maintenance practices to keep it working and prolong its life span. The installation and maintenance of photovoltaic cells call for the training and retraining of technical college teachers who will further impart the technical college students with the necessary skills and technique to install and maintain photovoltaic cells.
Maintenance according to Hakeem (2013) is any activity such as tests, measurements, replacements, adjustment and repairs intended to restore or retain a functional unit into a specified state in which the unit can perform its required functions. Islamiyah (as cited in Bakare&Amenger 2016. p16) defined maintenance as any action necessary for retaining or restoring piece of equipment, machine, or any system to the specified

operational condition to achieve its maximum useful life, which may be corrective maintenance or preventive maintenance.

According to Caribbean (as cited in Ogbu 2015.p15), Electrical and Electronic Technology is a field of study that provides both theoretical and hands-on knowledge of current flow in electrical and electronic devices and circuits. Hence, Electrical and Electronic trade curriculum is planned to provide the essential fundamental knowledge, practical and experimental skills necessary for a lifelong career in the field. It also provides students with fundamental knowledge and skills for the workplace and professional skills in electrical and electronic technology. Therefore, for effective acquisition of solar photovoltaic skills, instructional materials and facilities are necessary. Instructional materials and facilities on their own help to facilitate teaching and learning and can influence concrete and permanent change in students' behavior. The concrete and permanent change in student's behavior is very important as it enhances students' performance upon graduation and subsequent practice. Nevertheless, if this problem of unskilled craftsmen is not solved in good time especially with the wave of emerging technologies such as photovoltaic renewable energy resource, the crop of electrical/electronic students that will eventually graduates and enter into the work environment may suffer quackery.

STATEMENT OF THE PROBLEM

The adoption of reliable clean energy as an alternative source of power generation in Nigeria requires students and teachers to acquire skills and have versatile knowledge about solar photovoltaic technology. Solar photovoltaic technology which is relatively new technology in power generation is a sensitive means of power generation with challenges of installation, maintenance and inadequate equipment/facilities planning.
Installation and maintenance works taught by teachers of electrical and electronic trade is poised with potentials of equipping the students with prerequisite skills to propel them contribute meaningfully to the society, be self-reliant and job creators towards reduction of unemployment. Nevertheless, most electrical and electronic trade graduates roam the street unemployed because they cannot get employment or establish their own business due to lack of current saleable skills required by industries or self-sustainability. In Nigeria and Benue State in particular, Photovoltaic power installation and maintenance that is an emerging technology has poised more problems to

teachers and students of electrical/electronic work trade as many of them are not yet skillful in this area to impart it to others. There are insinuations that technical teachers who have long been on their teaching post without further retraining are more affected than those who left the school environment in recent time.

There are few technicians and craftsmen in Benue State who at present cannot effectively man solar installations and maintain faulty solar plants due to absence of the useful installation and maintenance competences required for the job. The training of electrical and electronics trade teachers and students to man such installations will reduce unemployment as they can be self-employed too. Hence, the identification and integration of relevant solar photovoltaic skills required by teachers of science and technical colleges in Benue State, Nigeria called for this study.

PURPOSE OF THE STUDY

The purpose of this study is to determine the Photovoltaic skills required for development of Electrical and Electronic trade teachers in science and technical colleges in Benue State Nigeria. Specifically the study seeks to:

1. Determine the solar photovoltaic installation skills required by teachers of electrical and electronic trade in Science and Technical colleges in Benue State.
2. Determine the solar photovoltaic maintenance skills required by teachers of electrical and electronic trade in Science and Technical colleges in Benue State.

Research Questions

In order to achieve the purpose of the study, the following research questions were formulated.

1. What are the photovoltaic cell installation skills required by teachers of electrical and electronic trade in science and technical colleges in Benue State?
2. What are the photovoltaic maintenance skills required by teachers of electrical and electronic trade in science and technical colleges in Benue State?

Hypotheses

Ho_1 There is no significant difference between the mean rating responses of electrical and electronic trade teachers with below five years and above

five years of teaching experience on the solar photovoltaic installation skills required by teachers of electrical and electronic trade in Science and Technical colleges.

Ho_2 There is no significant difference between the mean rating responses of electrical and electronic trade teachers with below five years and above five years of teaching experience on the solar photovoltaic maintenance skills required by teachers of electrical and electronic trade in Science and Technical colleges.

METHODOLOGY

The study adopted descriptive survey design. According to Osuala (as cited in Nwokolo, Odaba & Agada, 2018.p265) descriptive survey design is a design that studies characteristics and focuses on people, the vital facts of people and their beliefs, opinions, attitude, motivation and behavior. The descriptive survey design is appropriate for this study because it is aimed at determining the Photovoltaic skills required by electrical and electronic trade teachers of science and technical colleges in Benue State.
The study was conducted in Benue State, Nigeria. The population of the study was 55 electrical and electronic trade teachers teaching in 15 science and technical colleges in Benue State. The sample size of 55 respondents was drawn through purposive sampling technique since the population was manageable.

A 29 item structured questionnaire was used as instrument for data collection and was on a 4-point rating scale of strongly agree 4, agree 3, disagree 2, strongly disagree 1, for research question one (1) and research question two (2) respectively. Three experts from the Department of Vocational and Technical Education Benue State University Makurdi validated the instrument, which yielded a reliability coefficient value of 0.75. The researcher was able to distribute and collect back all the 55 copies of the questionnaire sent out to respondents. Data collected was analyzed using mean and standard deviation to answer the research questions, while t-test was used to test the hypotheses at 0.05 level of significance. The decision rule was to accept a null hypothesis if the p-value $\geq$ α-value, or reject same if the p-value $\leq$ α-value. Similarly, a mean rating value of 2.50 was used as cut-off point for accepting items as required or otherwise respectively.

RESULTS

Research Question 1

What are the photovoltaic cell installation skills required by teachers of electrical and electronic trade in science and technical colleges in Benue State?

Table 1. Mean rating responses and standard deviation on the solar photovoltaic installation skills required by teachers of electrical and electronic trade in science and technical colleges

S/No	Items Description	N	$\bar{X}$	SD	Remark
1	Apply statutory safety regulation for solar wiring system that are based on IEE and local wiring rules	55	3.45	0.662	Required
2	Solar photovoltaic system installation shall include the installation of all safety equipment and typical signs in accordance with the relevant standards	55	3.44	0.688	Required
3	Install the solar photovoltaic accessories as indicated on the working drawing	55	3.62	0.527	Required
4	Always cross check the current rating, voltage rating and power ratings of the solar panels, batteries, charge controllers and inverters before installation	55	3.51	0.663	Required
5	In solar PV modular system, the array should be 100Wp and the battery rating will be 100Ah	55	3.73	0.449	Required
6	The amount of solar power available per unit area (irradiation) should be measured using pyrometer before mounting the solar PV panels	55	3.80	0.404	Required

7	Solar trackers carrying 1 or 2 solar PV panels must be tilted either 12 degrees east or 12 degrees west, to obtain rain water that will run off to keep the panels clean	55	3.91	0.290	Required
8	Determine the cable size to be used for charge controllers and inverters	55	3.95	0.229	Required
9	The charge controller installed must match the system voltage (12V and or 24V system)	55	3.84	0.462	Required
10	Carry out continuity test, polar test and earth leakage test before and after installation of solar PV panels	55	3.78	0.567	Required
11	Bank of batteries should be installed in a separate cabinet close to their intended appliances	55	3.91	0.290	Required
12	Lighting protection may not be necessary if the building is already earthed	55	3.91	0.290	Required
	Grand mean	55	3.74		Required

The result presented in Table 1 indicates that the respondents agreed that all the 12 items presented as solar photovoltaic installation skills are required by teachers of electrical and electronic trade in Science and Technical colleges in Benue State. This is attested by their grand mean rating response value of 3.74.

Research Question 2

What are the solar photovoltaic maintenance skills required by teachers of electrical and electronic trade in science and technical colleges in Benue State?

Table 2. Mean rating response values and standard deviation on the solar photovoltaic maintenance skills required by teachers of electrical and electronic trade in science and technical colleges

S/No	Items Description	N	$\bar{X}$	SD	Remark
13	Select the right tools and equipment for troubleshooting faults in solar installations	55	3.95	0.229	Required
14	Isolate the solar panels and test all the units and write down the history of the fault	55	3.93	0.262	Required
15	Identify the symptoms, list all the possible causes of the problem then check the list of the possible causes against the list of the symptoms	55	3.91	0.290	Required
16	Tackle the suspected causes in the order of complexity, cost and time	55	3.69	0.540	Required
17	Record down the outcome of the trouble shoot and review same to the client	55	4.00	0.000	Required
18	Clean panels quarterly	55	3.09	0.290	Required
19	Check mechanical security of the array structure quarterly	55	3.09	0.290	Required
20	Check all cables for mechanical damage quarterly	55	3.73	0.449	Required
21	Check output voltage and current of each string of the array and compare it to the standard output rating quarterly	55	3.82	0.389	Required
22	Check electrical wiring for loose connections annually	55	3.91	0.290	Required
23	Check the operation of the charge controller annually	55	3.93	0.262	Required
24	Read and record the specific gravity of the battery monthly	55	3.73	0.449	Required
25	Check and record cell voltage monthly	55	3.55	0.503	Required
26	Check electrolyte level, top up where necessary	55	3.58	0.498	Required
27	Check all battery connections and cable terminations for security and corrosion	55	3.91	0.290	Required
28	Check for mechanical damage to battery cells	55	3.36	0.485	Required
29	Clean battery and battery area	55	3.36	0.485	Required
	Grand mean	55	3.68		Required

The result presented in Table 2 indicates that the respondents agreed on all the 17 items as solar photovoltaic maintenance skills required by teachers of electrical and electronic trade in Science and Technical colleges in Benue State. This is because the mean rating response values to the items ranged from 3.09 to 3.95 above the benchmark of 2.50 respectively.

Hypothesis One

Ho_1: There is no significant difference between the mean responses of electrical and electronic trade teachers with below five years and above five years of teaching experience on the solar photovoltaic installation skills required by teachers of electrical and electronic trade in Science and Technical colleges.

Table 3: t– test statistics on the mean rating responses of respondents on solar photovoltaic installation skills required by teachers of electrical and electronic trade in Science and Technical colleges

Years of Teaching	N	$\bar{X}$	SD	Df	t	P-Value	A	Decision
Below 5 Years	20	4.00	0.10	53	4.26	0.01	0.05	Rejected
5 Years & above	35	3.59	0.43					

The data presented in table 3 indicates that the two groups with degree of freedom of 53 had a t-value of 4.26 and a P- value of 0.01 at 0.05 level of significance. Since P-value is less than α-value, the null hypothesis is rejected. This indicates that there is a significant difference between the mean responses of electrical and electronic trade teachers with below five years and above five years of teaching experience on the solar photovoltaic installation skills required by teachers of electrical and electronic trade in Science and Technical colleges.

Hypothesis Two

Ho_2: There is no significant difference between the mean rating responses of electrical and electronic trade teachers with below five years and above five years of teaching experience on the solar photovoltaic maintenance skills required by teachers of electrical and electronic trade in Science and Technical colleges.

Table 4. t – test statistics on the mean rating responses of respondents on solar photovoltaic maintenance skills required by teachers of electrical and electronic trade in Science and Technical colleges

Years of Teaching	N	$\bar{X}$	SD	Df	t	P-value	A	Decision
Below 5 Years	20	3.91	0.05	53	6.93	0.01	0.05	Rejected
5 Years & above	35	3.54	0.23					

The data presented in table 4 show that the two groups with degree of freedom of 53 had a t- value of 6.93 and a P-value of 0.01 at 0.05 level of significance. Since P-value is less than α-value, the null hypothesis is rejected.

Major Findings of the Study

Based on the results obtained from the analyzed data, the following findings were deduced:

1. The study revealed twelve (12) solar photovoltaic installation skills required to develop teachers of electrical and electronic trade in science and technical collages. Thus, there was a significant difference between the mean rating responses of electrical and electronic trade teachers with below five years and above five years of teaching experience on the solar photovoltaic installation skills required by teachers of electrical and electronic trade in Science and technical colleges.
2. Seventeen (17) solar photovoltaic maintenance skills required in developing teachers of electrical and electronic trade in science and technical collages were also revealed. The study also found out that there was a significant difference between the mean rating responses of electrical and electronic trade teachers with below five years and above five years of teaching experience on the solar photovoltaic maintenance skills required by teachers of electrical and electronic trade in science and technical colleges.

DISCUSSION OF FINDINGS

Finding on solar photovoltaic installation skills required in developing teachers of electrical and electronic trade in science and technical collages indicates that teachers of science and technical colleges in Benue state require all the 12 skills identified in the study as important photovoltaic skills solar photovoltaic installation needed for their career development. The finding of this study agrees with Medugu (2011) who earlier found out that 65 percent of skills seem to be lacking in Electrical and Electronic teachers of science and technical colleges in Nigeria with photovoltaic cell installation inclusive, judging by the inadequacy and poor performances of craftsmen in solar photovoltaic installation and maintenance work activities.

Similarly, finding on photovoltaic maintenance skills revealed that seventeen (17) solar photovoltaic maintenance skills were required in

developing teachers of electrical and electronic trade in science and technical colleges in Benue state Nigeria. This result also buttress that of Ogbu, Afaor and Idoko, (2018) who worked on Design and construction of solar Photovoltaic battery charger and its educational implication with the submission that design and construction of solar Photovoltaic battery charger is a useful practical acquisition strategy towards improving technical teachers' and students' current deficiency in photovoltaic skill installation and maintenance activities.

The study also found out that there was a significant difference between the mean rating responses of electrical and electronic trade teachers with below five years and above five years of teaching experience on the solar photovoltaic installation and maintenance skills required by teachers of electrical and electronic trade in science and technical colleges in Benue state. The differences exhibited in their responses perhaps has risen from their training experiences from their school setting as photovoltaic skills were hitherto not in the curriculum of science and technical college students in Nigeria.

CONCLUSION

The study has identified twelve photovoltaic installation skills and seventeen solar photovoltaic maintenance skills required for the development of teachers of electrical and electronic trade in science and technical colleges in Benue State, Nigeria. These findings represent the opinion of electrical and electronic trade teachers with below five years of teaching experience and those with above five years of teaching experience who differs in their mean rating responses on these emerging technology skills. It is obviously clear that acquisition of the required solar photovoltaic skills by teachers is hinged on training and retraining of technical college teachers. This will enable electrical and electronic trade graduates to seek employment in renewable energy companies and as well as be able to establish their workshops and carry out installation work and maintain these photovoltaic facilities and contribute their own quota to the industrial development of Nigeria.

RECOMMENDATIONS

1 The identified photovoltaic installation and maintenance skills in this study should be incorporated into the training curriculum of science and technical college in Nigeria

2 Regular training and retraining courses and seminars should be organized for electrical and electronic trade teachers of science and technical colleges on solar photovoltaic installation and maintenance skills required to develop their competencies as this will equip those who graduated from their training institutions without these necessary emerging technology skills.

REFERENCES

Bakare, J.A. &Amenger, M. (2016).Ipad Maintenance Competences Required by Electrical/electronic Technology Students of Polytechnics for Job Creation in Lagos State. *A Journal of Research in Science, Vocational and Engineering Technology Education*1 (1), 14-22.

Hakeen, H. (2013). Meaning of Maintenance. Retrieved from www.conceptmaintenance/education.

Iliya, M.U. (2017). Perceived Competency needs of Automobile Technology Education Teachers in colleges of Education in North-Eastern States of Nigeria. *Journal of Nigerian Association of Teachers of Technology* 12(4).116.

Jubrin, A. Okworo, R.O., Hassan, A.M. &Jatau, R.S. (2018). Skills Improvement need of Woodwork Teachers in Technical Colleges in Kano State, Nigeria. *Benue State University Journal of Education* 18 (1).38.

Khalidin, Z. &Sujod, M. Z. (2010).*Safe Energy Resources Photovoltaic Training Module 1*, Kaduna.www.safe-energyresources.com

Medugu, J.D. (2011). *Effectiveness of a Digital Oscilloscope for the Teaching of Some Radio, Television and Electronics Work Concept at Technical Colleges Level*. Unpublished PhD Thesis. Ababakar Tafawa Balewa University, Bauchi, Nigeria

NBS (2017).*National Bureau of Statistic Report on Energy* Abuja. Retrieved from www.nbs.gov.ng

Nwokolo, O.J.O., Odaba, I.J., &Agada, C.N. (2018). Issues Confronting Sustainable Quality Skills Development of Metal Work Technology in Science and Technical Colleges in Benue State, Nigeria. *Benue State University Journal of Education*18 (1).262-270.

Ogbu, J. E. (2015). Influence of Inadequate Instructional Materials and Facilities in Teaching and Learning of Electrical/Electronic Education Courses. *A Journal of Education and Practice*6(3).15. Retrieved fromwww.iist.org

Ogbu, S. O., Afaor, N.N, &Idoko, G. O. (2018). Design and Construction of a Solar Battery Charger and its Educational Implications. *Benue State University Journal of Education* vol. 18 (1).19.

Ranabhat, K., Patrikeec, L., Revina, A. A., Andrianov, K., Lapshinsky, V. &Sofronova, E.(2016). *An Introduction to Solar Technology.* Moscow.