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Competencies Needed by Electrical/Electronic Technology Education Graduates for Installation of Solar Energy Systems for Sustainable Self-Employment in Enugu State

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Abstract: *The main purpose of this study was to determine the installation competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State. Three research questions and three null hypotheses were developed to guide the study. The study adopted descriptive survey research design. The study population was 91 comprised 73 graduate solar practitioners installing and maintaining solar system and 18 electrical/electronics technology education lecturers in public universities in Enugu State. There was no sampling as the entire population was studied. The instrument for data collection was a 31-item structured questionnaire divided in three sub-categories based on the research questions that was made for the study. The questionnaire items were structured in four-point rating scale. The questionnaire was validated by experts, while the reliability of the instrument yielded 0.78 using Cronbach Alpha. Out of 91 copies of questionnaire distributed 80 copies were properly filled and returned giving 87.91% return rate. The data collected were analyzed using mean, standard deviation and t-test statistics. Based on the results of data analysis, the study found that theoretical competencies, practical skills and entrepreneurial competencies were needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State. Based on the findings, knowledge of solar panel assembly, ability to understand electrical systems, ensuring correct mounting of solar panels with accessories, performing maintenance tasks such as measurement, setting appropriate business goals and determining what customers need are needed for installation of solar energy for sustainable self-employment in Enugu State. Recommendations were made among which include; government and relevant bodies should adopt the identified competencies in preparing the students for self-employment in solar system installation and technology educators should utilize relevant materials in developing the students' competencies in solar systems installation and maintenance.*

Keywords; Installation competencies, electrical/electronic technology education graduates, solar energy system, sustainability, and self-employment

INTRODUCTION

Energy is the lifeblood of modern society, powering our homes, industries, and economies. Its sources range from non-renewable options like fossil fuels and nuclear energy to renewable alternatives such as wind, hydropower, and solar energy. Among these, solar energy stands out for its abundance and cleanliness. Solar energy, derived from radiant light and heat from the Sun, offers immense promise for sustainable development and economic empowerment.

In Enugu State, Nigeria, where abundant sunlight bathes the region year-round, solar energy presents a compelling opportunity for sustainable self-employment. Sustainable self-employment involves running a business or working for oneself in a manner that not only generates income but also prioritizes long-term environmental, social, and economic sustainability.

The transition to solar energy systems for sustainable self-employment requires more than just access to technology; it demands a skilled workforce equipped with the necessary competencies to design, install, and maintain these systems effectively. As the global demand for energy continues to rise, there is a growing imperative to transition towards sustainable and renewable sources. In this context, the installation of solar energy systems holds particular promise for small and medium-scale activities.
According to Orakwe (2022) renewable energy production especially in the case of installation of solar energy systems have provided a promising landscape for electrical energy production for small and medium scale activities. The production of electrical energy through solar system installation requires the training of students in public universities to address the needs of renewable energy production.

In Enugu State, there are two public universities that train students especially in electrical/electronics technology education (University of Nigeria Nsukka, and Enugu State University of Science and Technology). These universities are expected to equip the students with the needed competencies to become self-employed or secure a paid employment after graduation. Enugu State, like many regions, faces the challenges of energy access and environment sustainability. Recognizing the potential of solar energy as a clean and renewable source, there is a growing interest in harnessing this power for both personal and community use.

Solar system installation in the concept of this study, is the harnessing of energy from the sunlight and converting it into electricity through photovoltaic cells, utilizing inverters, charge controls and grid connections. Solar power, with its inherent renewable nature and minimal environmental impact, has emerged as a beacon of hope for sustainable energy generation in modern society (Jark, 2016). The solar system installation for energy generation has become the needs of the society based on the need to reduce reliance on traditional fossil fuels and this has led to a significant surge in demand for skilled professionals capable of harnessing the power from the sun. Installing a solar system typically involves mounting solar panels in an open area (such as a roof), connecting them to an inverter and integrating the system with your

electrical grid. As the world grapples with the consequences of climate change, there is an escalating recognition of the need for eco-friendly energy alternatives such as solar system (Tyagi, Rahim and Selvaraji, 2018). This involves setting up the infrastructure necessary to harness solar power for various applications, such as electricity generation or heating.

There are specific competencies aim skills needed to be able to achieve this feat. Therefore, the study delves into the specific competencies and skill sets that electrical/electronics technology education graduates from institutions of higher learning like universities should possess to engage in the installation of solar energy systems for sustainable self-employment. Here, instead of searching for traditional employment, the emphasis is on graduates establishing their own businesses or ventures and creating values that will address the needs of the society. Self-employment when sustainable can lead to economic growth and attainment of steady economy and development. Boylan & Buchard (2015) opined that self-employment is a situation in which an individual works for himself or herself instead of working for an employer that pays a salary or a wage. Self-employed youths contribute to the human resources needed for social-cultural, economic and technological development of a nation. Self-employment of the youths depends on their proficiency in acquisition of relevant competencies required in occupational fields. Self-employment in this study is for one who has acquired relevant skills while in school to effectively contribute to the implementation and expansion of solar energy initiatives, installation and maintenance. Therefore, graduates must be equipped with the necessary competencies needed for sustainable self-employment.

Competencies are set of skills, knowledge and abilities that individuals must have to effectively perform a particular task or job. In this context, the competencies are requisite skills, abilities necessary for installing solar energy systems. Competency according to Bakare, Okereke and Obe (2017) is the combination of knowledge, skills and attitudes needed for carrying out a task. Competency is essentially knowledge, skills and attitudes needed for carrying out a task. According to Mbah in Ohagwu (2023) competence serves as a motivated pattern of knowledge, skills and interpersonal abilities deployed to undertake a valued job. It is the combination of observable and measurable knowledge, skills and abilities as well as personal attributes that contributes to enhanced employee performance which ultimately result in organizational success (Ismail and Mohammed, 2015). The competencies needed in renewable energy production is novel to the educational system based on the information technology and solar system installation and maintenance.

The study explores the diverse aspects of solar energy installation, ranging from technical know-how to project management skills for self-employment. This study focused on the theoretical knowledge, practical competencies and entrepreneurial competencies required for electrical/electronics technology education graduates to become successful and self-employable in the solar energy sector. The theoretical knowledge covers the fundamental principles and general education knowledge about the solar system installation and maintenance, design and compositions of solar system. Theoretical knowledge in this solar energy system requires one to possess adequate general education for the electrical/electronics, component setup, application and installation. Mbah (2016) pointed that theoretical knowledge facilitate the gathering and

utilization of relevant information in solar system and electrical energy generation. This theoretical knowledge would enable graduates acquire and understand practical competencies to become occupationally relevant in solar system installation and maintenance.

Practical competencies are manual dexterity that is used to perform specific operation. Practical competency in solar installation and maintenance is the ability to perform a task creditably to achieve desired results in solar energy production (Orakwe, 2021). Further, practical competencies are the manipulative psychomotor abilities used in the performance of task. The practical skills cover the abilities to use the brain, hand and legs in manipulating tools and machines while carrying out installation, component setup, trouble-shooting, testing and maintenance of solar system for energy generation. The practical skills are needed for sustainable self-employment as well as for entrepreneurship ventures. The success achievable in becoming self-employed and business owner, depend largely on the possession of entrepreneurial skills needed in the business by the individual.

Entrepreneurial skills are the abilities required by individual to identify business opportunity and utilize resources in order to make profit therein. Entrepreneurial competencies according to Onoh (2015) and Ajayi (2017) are the abilities one is expected to possess to be able to assume, manage and sustain a business venture. Such competencies include planning skills, innovative skills, marketing skills, management skills among others. If universities equip electrical/electronics technology education graduates with the skills and mindset to pursue self-employment as a viable option alongside traditional paid employment, it demonstrates a holistic approach to education that prepares individuals for diverse career paths and fosters entrepreneurial spirit. This ensures that electrical/electronics technology education graduates have the flexibility and adaptability to thrive in various professional settings, contributing positively to innovation, economic growth, and societal advancement. Including entrepreneurial skills in solar energy installation competencies is essential for several reasons: business opportunities, market differentiation, customer relations, innovation and adaptability, problem-solving, business sustainability. Incorporating entrepreneurial skills into solar energy installation competencies not only enhances the professional capabilities of individuals in the industry but also fosters innovation, growth, and sustainability within the broader renewable energy sector. It is therefore imperative to investigate the competencies that the electrical/electronics technology education graduate need to become self-employed in solar system installation and maintenance.

To achieve this, there is need to collaboratively determine competency clusters with the help of lecturers and graduate practitioners in the field. Lecturers are professionals who specialize in teaching courses related to electrical and electronics engineering, technology, or related fields. They are responsible for delivering lectures, conducting laboratory sessions, and facilitating hands-on learning experiences to help students understand theoretical concepts and gain practical skills. The lecturers of electrical/electronics technology education in the universities have professional and pedagogical experience to determine the competencies for self-employment of the graduates in solar installation and maintenance.

Graduate Practitioners here are graduate professionals who work in various capacities within the solar energy industry. They contribute to the design, installation, operation, maintenance, research, and development of solar energy systems and technologies. The graduate practitioners also played a role as their professional and practical experiences would help the researcher in revalidating the identified solar system installation and maintenance for self-employment of the electrical/electronics technology education graduates in Enugu State.

Statement of the Problem

The integration of solar energy systems into Enugu State's energy production framework holds promise for sustainable development. However, a critical examination reveals a significant gap in the competencies needed by electrical/electronics technology education graduates to effectively contribute to the installation of solar energy infrastructure for self-employment. This deficiency in training poses substantial challenges, as graduates may lack the necessary skills and knowledge to meet the demands of the evolving solar energy sector. Consequently, the consequences of this skills gap extend beyond individual graduates to impact the region's economic prosperity and environmental sustainability.

Without adequate competencies in solar energy systems installation and maintenance, electrical/electronics technology education graduates face limited opportunities for meaningful self-employment in Enugu state's burgeoning renewable energy market. The inability to effectively harness solar energy not only hampers graduates' entrepreneurial endeavors but also perpetuates reliance on conventional, non-renewable energy sources. This dependence not only inhibits economic diversification but also contributes to environmental degradation and energy insecurity.

Furthermore, the absence of skilled professionals in solar energy installation impedes the region's progress towards achieving sustainable development goals. Inadequate solar infrastructure limits access to reliable electricity, hindering educational, healthcare, and economic activities in communities across Enugu state. This perpetuates cycles of poverty and unemployment, exacerbating social inequalities and diminishing prospects for inclusive growth.

Therefore, the urgency of addressing the competency gap among electrical/electronics technology education graduates for meaningful participation in solar energy installation for self-employment in Enugu state cannot be overstated. By equipping electrical/electronics technology education graduates with the requisite skills and knowledge, Enugu state can unlock the full potential of its renewable energy resources, foster economic empowerment, and pave the way for a more sustainable and prosperous future for its citizens. Consequently, the statement of the problem centers on the need to identify, and address the key competencies required among electrical/electronics technology education graduates for meaningful participation in the installation of solar energy systems for sustainable self-employment in Enugu state.

Purpose of the Study

The main purpose of this study was to determine the competencies needed by graduates of electrical/electronics technology education for installation of solar energy system for sustainable self-employment in Enugu State. Specifically, the study sought to determine the;

1. theoretical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.
2. practical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.
3. entrepreneurial competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

Research Questions

The following research questions guided the study;

1. What are the theoretical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State?
2. What are the practical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State?
3. What are the entrepreneurial competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State?

Hypotheses

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

HO_1: There is no significant difference between the mean responses of electrical/electronics technology education lecturers and graduate practitioners on the theoretical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

HO_2: A significant difference does not exist between the mean responses of the electrical/electronics technology education lecturers and graduate practitioners on the practical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

HO_3: There is no significant difference between the mean responses of electrical/electronics technology education lecturers and graduate practitioners on the entrepreneurial competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

METHODS

The study adopted a descriptive survey research design. Nworgu (2015) defined survey research design as one in which a group of people or items are studied by collecting and analyzing data from only a few of

them within the entire group. The study adopted this design due to the polychotomous instrument used and the basic technology education teachers' opinions which were sought. The area of the study was Enugu State of Nigeria. Enugu State is located in Igboland. It is one of the five States in South-East geopolitical zone of Nigeria. The State like other States in Nigeria, has challenge in the power sector which the use of solar power systems as a renewable energy can address. The population for the study was 91 comprised 73 graduate solar practitioners installing and maintaining solar system and 18 electrical/electronics technology education lecturers in public universities in Enugu State. The population was determined based on the field survey conducted by the researcher in January 2024 on the registered graduate solar practitioners in Enugu State. There was no sampling as the population was manageable for the researcher's capacity.

The data collection was done using a 31-item structured questionnaire developed by the researcher based on the review of related literature. The instrument was structured in four-point response scales of highly needed (HN), needed (N), slightly needed (SN), and not needed (NN), with a numerical weight of 4,3,2, and 1 respectively.

The validation of the instrument was done using three experts, two (2) in Department of Technology and Vocational Education, and one (1) in Measurement and Evaluation in Enugu State University of Science and Technology in Enugu State. Their corrections and suggestions were used to prepare the final draft of the instrument used for the study. The instrument was trial tested using 4 copies on electrical/electronics technology lecturers in Ebonyi State University and 6 copies on graduate practitioners in Ebonyi State, who were not in the area of the study. The reliability coefficient yielded 0.78 using Crombach Alpha method. This 0.78 coefficient is in-line with Uzoagulu (2013) that reliability index of 0.60 to 1 show that the instrument is reliable and could be used for the data collection.

The administration of the questionnaire was carried out using eight research assistants and out of 91 copies of questionnaire distributed 80 copies were properly filled and returned giving 87.91% return rate. Weighted means and standard deviations were used to answer the research questions. Decisions on the research questions were made using the lower and upper limits of the mean based on a four-point rating scale. The standard deviation was used to determine the homogeneity or otherwise of the opinions of the respondents. The t-test was used to test the null hypotheses. The analysis was carried out using Statistical Package for Social Sciences (SPSS). The significant value (at 2-tail) was compared with .05 level of significance at the appropriate degree of freedom. The null hypothesis was not significant when the significant value was less than the .05 level of significance and at appropriate degree of freedom; otherwise, the null hypothesis was significant.

RESULTS

The results of the study obtained were presented in Tables based on the research questions that guided the study, and the null hypotheses that were tested in the study (see Tables 1-6).

Research Question 1

What are the theoretical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State?

Table 1: Mean ratings and standard deviation of the respondents on the theoretical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

S/N	theoretical competencies needed include knowledge of,	Lecturers N= 12		Graduate Practitioners N= 68		Overall		Decision
		$\overline{X}_1$	SD_1	$\overline{X}_2$	SD_2	$\overline{X}_G$	SD_G	
1	different solar system components like solar panels, inverters, batteries	3.18	0.67	3.24	0.65	3.22	0.65	Highly Needed
2	solar panel assembly	3.39	0.63	3.35	0.63	3.37	0.62	Highly Needed
3	photovoltaic technology	3.46	0.51	3.45	0.58	3.46	0.55	Highly Needed
4	and understanding electrical systems	3.46	0.64	3.45	0.64	3.46	0.64	Highly Needed
5	mounting and wiring	3.18	0.55	3.31	0.62	3.27	0.59	Highly Needed
6	environmental considerations	3.17	0.54	3.37	0.56	3.30	0.56	Highly Needed
7	the rules in installation and maintenance	3.11	0.74	3.31	0.71	3.24	0.72	Highly Needed
8	site assessment in solar installation	3.18	0.67	3.35	0.66	3.29	0.66	Highly Needed
	Cluster Mean/SD	**3.27**	**0.62**	**3.35**	**0.63**	**3.33**	**0.62**	**Highly Needed**

The result of data analyses presented in Table 1 above show that the cluster mean rating of electrical/electronics technology education lecturers and graduate practitioners are 3.27 and 3.35 respectively which represents highly needed. The overall mean rating of the respondents ranges from 3.22 to 3.46 indicating highly needed. The implication is that the identified items are the theoretical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State. The overall cluster mean of 3.33 further reveals that the itemized are the theoretical competencies needed by electrical/electronics technology

education graduates for installation of solar energy systems for sustainable self-employment in Enugu State. The low standard deviation of 0.62 shows that the respondents' opinions do not differ remarkably.

Hypothesis 1

There is no significant difference between the mean ratings of electrical/electronics technology education lecturers and graduate practitioners on the theoretical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

Table 2: Summary of t-test analysis of mean ratings of electrical/electronics technology education lecturers and graduate practitioners on the theoretical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

Variables	N	t	df	Sig. (2tailed)	Mean Difference	Std. Error Difference	Decision
Lecturers	12	0.429	78	0.315	0.57019	1.66412	NS
Graduate Practitioners	68						

The results of t-test analysis in Table 2 show that the t-value at .05 level of significance and 78 degrees of freedom for the items is .429 with a significant value of .315. Since the significant value of .315 is more than the .05 level of significance the null hypothesis is not significant. This means that there is no significant difference with respect to the items on the mean ratings of electrical/electronics technology education lecturers and graduate practitioners theoretical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

Research Question 2

What are the practical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

Table 3: Mean ratings and standard deviation of the respondents on the practical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

S/N	practical competencies needed include ability to;	Lecturers N= 12		Graduate Practitioners N= 68		Overall		Decision
		$\overline{X}_1$	SD_1	$\overline{X}_2$	SD_2	$\overline{X}_G$	SD_G	
9	ensure correct mounting of solar panels with accessories	3.03	0.79	3.18	0.71	3.13	0.74	Highly Needed
10	perform maintenance tasks such as measurement, cut and installation of wire in solar system	2.82	0.90	3.06	0.81	2.97	0.85	Highly Needed
11	work on multi-conductor cables	2.89	0.96	3.10	0.85	3.03	0.89	Highly Needed
12	install unshielded twisted pair cables	2.89	0.96	3.09	0.85	3.02	0.89	Highly Needed
13	uninstall faulty solar system	3.18	0.77	3.20	0.75	3.19	0.75	Highly Needed
14	carry out surface wiring with the appropriate tools	3.07	0.76	3.04	0.74	3.05	0.74	Highly Needed
15	identify polarities in components	3.14	0.71	3.02	0.76	3.06	0.73	Highly Needed
16	select appropriate cables	3.21	0.83	3.10	0.81	3.14	0.81	Highly Needed
17	identify materials, equipment with tools used for installation and maintenance	3.36	0.68	3.09	0.85	3.19	0.80	Highly Needed
18	conduct simple test on battery	3.21	0.57	3.00	0.75	3.08	0.69	Highly Needed
19	protect battery terminals from corrosion	3.14	0.65	2.90	0.76	2.99	0.72	Highly Needed
20	interpret electrical wiring diagram for buildings and equipment	3.23	0.68	3.27	0.70	3.24	0.71	Highly Needed
21	Test the solar system installation based on the voltage supplied	3.04	0.64	3.10	0.64	3.08	0.64	Highly Needed
	Cluster Mean/SD	**3.32**	**0.76**	**3.09**	**0.77**	**3.09**	**0.71**	**Highly Needed**

The analyses of data in Table 3 show that the cluster mean rating of electrical/electronics technology education lecturers and graduate practitioner are 3.32 and 3.09 respectively which represents highly needed. The overall mean rating obtained for the 13 items ranges from 2.97 to 3.19 indicating highly needed. This means that the items are the practical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State. An overall cluster mean of 3.09 and cluster standard deviation of 0.71 also depicts that the itemized are practical competencies needed electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment. The relatively low standard deviation value of 0.71 indicates that the respondents did not differ remarkably in their opinions regarding the items as practical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

Hypothesis 2

A significant difference does not exist between the mean scores of the electrical/electronics technology education lecturers and graduate practitioners on the practical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

Table 4: Summary of t-test analysis of mean ratings of electrical/electronic technology education lecturers and graduate practitioners on the practical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

Variables	N	t	Df	Sig. (2tailed)	Mean Difference	Std. Error Difference	Decision
Lecturers	12	0.825	78	0.121	.54776	1.68078	NS
Graduate Practitioners	68						

The results of t-test analysis in Table 4 show that the t-value at .05 level of significance and 78 degrees of freedom for the items is 0.825 with a significant value of .121. Since the significant value of .121 is more than the .05 level of significance, the null hypothesis is not significant. This means that there is no significant difference between the mean ratings of electrical/electronics technology education lecturers and graduate practitioners on the practical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

Research Question 3

What are the entrepreneurial competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

Table 5: Mean ratings and standard deviation of the respondents on the entrepreneurial competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

S/N	Entrepreneurial competencies needed include ability to;	Lecturers N= 12		Graduate Practitioners N= 68		Overall		Decision
		$\bar{X}_1$	SD_1	$\bar{X}_2$	SD_2	$\bar{X}_G$	SD_G	
22	set appropriate business goals	3.29	0.60	3.14	0.60	3.19	0.60	Highly Needed
23	plan effectively for goal attainment	3.32	0.67	3.12	0.71	3.19	0.70	Highly Needed
24	relate properly with colleagues and customers	3.25	0.65	3.10	0.67	3.15	0.66	Highly Needed
25	recognize the need for employee growth and development	3.29	0.53	3.14	0.63	3.19	0.60	Highly Needed
26	determine what customers need	3.36	0.56	3.16	0.67	3.23	0.64	Highly Needed
27	request feedback information from customers	3.29	0.53	3.16	0.64	3.20	0.61	Highly Needed
28	Identify opportunity in solar installation and maintenance	3.43	0.57	3.20	0.72	3.28	0.68	Highly Needed
29	conduct feasibility study on the solar system installation	3.36	0.56	3.16	0.73	3.23	0.68	Highly Needed
30	manage time and meet job schedules	3.36	0.56	3.08	0.82	3.18	0.75	Highly Needed
31	accept faults when identified and effect correction when necessary	3.23	0.68	3.27	0.70	3.24	0.71	Highly Needed
	Cluster Mean/SD	**3.32**	**0.59**	**3.15**	**0.69**	**3.21**	**0.60**	**Highly Needed**

The analyses of data in Table 5 show that the cluster mean rating of electrical/electronics technology education lecturers and graduate practitioners are 3.32 and 3.15 respectively which represents highly needed. The overall mean rating obtained for the 10 item ranges from 3.15 to 3.28 indicating highly needed. This means that the items are the entrepreneurial competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State. An overall cluster mean of 3.21 and cluster standard deviation of 0.60 also depicts that the itemized are entrepreneurial competencies needed by electrical/electronics technology education graduates for

installation of solar energy systems for sustainable self-employment. The relatively low standard deviation value of 0.72 indicates that the respondents did not differ remarkably in their opinions regarding the items as the entrepreneurial competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

Hypothesis 3
There is no significant difference between the mean ratings of electrical/electronics technology education lecturers and graduate practitioners on the entrepreneurial competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

Table 6: Summary of t-test analysis of mean ratings of electrical/electronics technology education lecturers and graduate practitioners on the entrepreneurial competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

Variables	N	t	df	Sig. (2tailed)	Mean Difference	Std. Error Difference	Decision
Lecturers	12	0.329	78	0.527	.54776	1.68078	NS
Graduate Practitioners	68						

The results of t-test analysis in Table 6 show that the t-value at .05 level of significance and 78 degrees of freedom for the items is 0.329 with a significant value of .527. Since the significant value of .527 is more than the .05 level of significance, the null hypothesis is not significant. This means that there is no significant difference between the mean ratings of electrical/electronics technology education lecturers and graduate practitioners on the entrepreneurial competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

DISCUSSION OF THE FINDINGS

Based on the data analyses, the following findings were made according to the research questions that guided the study and the null hypotheses tested for the study. According to research question one, the study showed the theoretical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State. The study found that the highly needed theoretical knowledge include; knowledge of different solar system components like solar panels, inverters, batteries, knowledge of solar panel assembly, knowledge of Photovoltaic technology, ability to understand electrical systems, knowledge of mounting and wiring, knowledge of

environmental considerations, ability to observe the rules in installing and maintenance and knowledge of site assessment in solar installation.

The implication is that the identified items are the theoretical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State. The findings of the study were in line with Orakwe (2022) that theoretical knowledge is a vital point in solar installation and maintenance. Moreso, the findings of the study indicated that there was no significant difference between the mean responses of electrical/electronics technology education lecturers and graduate practitioners on the theoretical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State. The implication of the findings was that the status of the respondents had no influence on the identified theoretical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment.
by graduate of public universities for installation of solar energy for self-employment.

Furthermore, the findings of the study with respect to research question two depicted the practical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State. Among the identified practical competencies required by graduate of public universities for installation of solar energy includes ability to; ensure correct mounting of solar panels with accessories, perform maintenance tasks such as measurement, cut and install wire in solar system, work on multi-conductor cables, install unshielded twisted pair cables, uninstall faulty solar system, carry out surface wiring with the appropriate tools, identify polarities in components, identify materials, equipment with tools used for installation and maintenance, conduct simple test on battery, protect battery terminals from corrosion, interpret electrical wiring diagram for buildings and equipment and test the solar system installation based on the voltage supplied. The findings of the study were supported by Tyagi, Rahim and Selvaraj (2018) who pointed out that practical skills are necessary in the installation and maintenance of solar system. This means that the items are the practical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State. The study also found that a significant difference does not exist between the mean scores of the electrical/electronic technology education lecturers and graduate practitioners on the practical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State. This implies that the status of the respondents (lecturers and graduate practitioners) had no influence on the identified practical competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State.

The findings were in line with Mbah (2016) that there was no significant difference between the responses of teachers and graduate practitioners on the practical skills needed for self-employment. Furthermore, the findings of the study according to research question three indicated that entrepreneurial competencies are needed by electrical/electronics technology education graduates for installation of solar energy systems for

sustainable self-employment in Enugu State. The highly required entrepreneurial competencies for installation of solar energy include ability to; set appropriate business goals, plan effectively for goal attainment, relate properly with colleagues and customers, recognize the need for employee growth and development, determine what customers need, request feedback information from customers, identify opportunity in solar installation and maintenance, conduct feasibility study on the solar system installation, manage time and meet job schedules and accept faults when identified and effect correction when necessary. This means that the itemized are entrepreneurial competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment. The findings of the study were in agreement with Ajayi (2017) that entrepreneurship skills are highly needed by electrical/electronics technology education graduates for self-employment. This therefore revealed that entrepreneurship competencies are needed for self-employment in solar system installation and maintenance. The result of null hypothesis showed that there was no significant difference between the mean ratings of electrical/electronics technology education lecturers and graduate practitioners on the entrepreneurial competencies needed by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment in Enugu State. This means that the identified entrepreneurial competencies are not influenced by the status of the respondents for installation of solar energy for self-employment in Enugu State.

CONCLUSION

The study identified the competencies required by electrical/electronics technology education graduates for installation of solar energy systems for sustainable self-employment. The study depicts that graduates need to develop their competencies in solar system installation and maintenance based on the identified theoretical, practical and entrepreneurial competencies. This is pertinent as the lecturers in electrical/electronics technology education need to train their students before graduation on the needed competencies to be self-employed. The identified competency areas were based on the responses of the lecturers and graduate practitioners of solar system installation and maintenance. These competence areas need to be integrated into the curriculum and skill acquisition programme of the schools. This is pertinent as there is increasing needs to achieve the desired growth, development and self-employment of electrical/electronics technology education graduates in Enugu State in solar installation and maintenance.

Recommendations

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

1. Universities and relevant bodies should adopt the identified competencies in preparing the students for self-employment in solar system installation.
2. Electrical/electronics technology education lecturers should utilize relevant materials in developing the students' competencies in solar system installation and maintenance.
3. The students on graduation should ensure that the identified competencies are acquired for self-employment in solar system installation and maintenance.

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