Improving Electrical Machines Maintenance Skills of Technical Teachers and Trainers: A Competency Based Approach

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Abstract- ***The rapid advancement of electrical machines and automation technologies has heightened the demand for skilled technical personnel, yet many technical teachers lack the necessary competencies to impart practical maintenance skills. This study examined the effectiveness of the Competency-Based Approach (CBA) in enhancing electrical machine maintenance skills among technical teachers and trainers. A diagnostic research design was employed for a comprehensive investigation on the status of implementation of CBA. A population of 30 respondents was used for the study based on purposive sampling technique. Data were collected using a Self-Rating Competency-Based Educators' Questionnaire (SRCEQ), The instrument was developed with Cronbach Alpha internal consistency of 0.89. Descriptive statistics and t-tests at 0.05 significance level were used for data analysis. Findings indicated that trainers implemented CBA strategies more effectively than teachers, focusing on hands-on exercises, skill-based instructional materials, and real-life problem-solving. CBA procedures significantly improved students' confidence, innovation, fault diagnosis, and industry readiness. However, challenges such as inadequate funding, a shortage of trained personnel, and limited mentorship programs hindered effective implementation. Coping strategies included improvisation and industry partnerships. The study concludes that CBA enhances technical training by fostering maintenance skills and industry readiness. To maximize its impact, continuous professional development, increased funding, industry-academia collaboration, access to modern equipment, and standardized assessments should be prioritized. Strengthening these strategies will better equip technical educators to train future professionals in electrical machine maintenance.***

Indexed Terms- ***Competency, Training, implementation, procedures, strategies.***

I. INTRODUCTION

The rapid advancement of electrical machines and automation technologies has significantly increased the demand for highly skilled technical personnel who can efficiently maintain, troubleshoot, and repair these machines (Zhou et al., 2023; Khan et al., 2022). Effective maintenance of electrical machines is critical for ensuring the reliability, safety, and efficiency of industrial and educational systems. However, recent studies indicate that many technical teachers and trainers lack the necessary competencies to impart practical maintenance skills to learners effectively (Olawale & Ogunleye, 2023). This gap underscores the need for a structured, competency-based training approach that enhances technical educators' proficiency in electrical machine maintenance.

Competency-Based Education (CBE) has emerged as a pivotal framework in Technical and Vocational Education and Training (TVET), emphasizing the demonstration of specific skills and competencies over traditional time-based learning. This approach ensures that learners acquire the practical abilities required to meet industry standards, thereby enhancing their

readiness for the workforce (Okolie, Nwosu̧ & Igwe, 2021). International standards underscore the importance of CBE in TVET systems. For instance, UNESCO highlights that a Competency-Based TVET System employs powerful techniques to address the needs of various industry sectors, ensuring that courses and training programs are developed in alignment with these demands (UNESCO, 2022).

Competency-Based Education and Training (CBET) has emerged as a globally recognized framework for skills development, focusing on learners' ability to perform specific tasks to industry standards rather than simply acquiring theoretical knowledge (UNESCO, 2022; Mulder, 2021). CBET emphasizes hands-on training, problem-solving, and real-world application, making it particularly relevant for technical and vocational education and training (TVET) programs (Adams et al., 2022).

Technical and Vocational Education and Training (TVET) emphasize the crucial role of Competency-Based Education (CBE) in designing training programs, as highlighted by UNESCO; essentially, a CBE approach within TVET allows for the tailored development of courses and training specifically to meet the needs of different industries, ensuring graduates possess the exact skills required by the job market. In consideration to designing of training programs, Odewale, Jimba, Shodipe, Ohanu, & Ede (2024) stated that curriculum problems in electrical installation and maintenance work in Nigeria are the issues related to the design and implementation of educational programmesss. They added that these problems call for a paradigm shift from limitations on training imposed by inadequate literacy skills of apprentices and trainers in the informal and formal sector towards stimulating technical, entrepreneurial skills and sustainability (CBET).

In the context of electrical machine maintenance, CBE focuses on equipping technical teachers and trainers with the necessary competencies to effectively impart maintenance skills. This involves a structured methodology where educators guide learners through progressively complex tasks, ensuring mastery at each stage before advancing. Such a model not only aligns with industry requirements but also promotes a deeper understanding of maintenance practices among students. Furthermore, the International Association for Continuing Education and Training (IACET) provides guidelines emphasizing the need for processes that ensure learners demonstrate the required competencies, thereby maintaining the quality and relevance of training programs (IACET, 2018; Nwoke, & Ibe, 2022).

The implementation of CBET has the potential to equip teachers and trainers with industry-relevant competencies, ensuring that they can effectively transfer these skills to students (Adams et al., 2022). Despite its advantages, research suggests that the adoption of CBET in technical training institutions remains inconsistent due to challenges such as inadequate infrastructure, lack of industry collaboration, and insufficient professional development for educators (Ayonmike & Okeke, 2022). It was further observed that regardless of the recognized benefits of CBE, challenges persist in its implementation, particularly in developing regions (Lawal, & Adegbite, 2020). A study assessing the technical skills competency needs of electrical installation and maintenance work trade teachers in Yobe State revealed gaps in the effective application of CBE methodologies. The findings suggest a need for enhanced training programs and resources to support educators in adopting competency-based approaches (Abdullahi, 2020).

The teachers remain instrumental in the success or failure of any curriculum (Loflin, 2016). In a study on the primary physical education curriculum process, Jess, Carse & Keay (2016) found the need to prepare and train teachers to meet the objectives of any given curriculum. They argued that teachers need the capacity to design developmentally appropriate learning tasks that are aligned to curricular expectation. The focus of training and professional development requires emphasis on teaching and how best to interpret the curriculum so that students' needs will align with appropriate instructional practices (Jen Kins, 2018). Therefore, if what students are to learn need to go beyond rote, then, there is need to be a concomitant shift in teacher pedagogy to match by scaling the cloud (Inyang-Abia, 2018).

A competency-based approach consists of a framework which identifies the key competencies and

skills that technical teachers and trainers need to possess in order to effectively teach maintenance-related subjects. These competencies encompass a wide range of areas, such as *technical expertise, communication skills, problem-solving abilities, hands-on experience, and recognition of industry trends.* However, Onuma (2016) and Eze & Nwogu (2021) blamed the high rate of university graduate unemployment to lack of collaboration between lecturers and methods of pedagogy delivery; adding that the graduates roam the streets and the job-markets looking for non-existent jobs for lack of requisite skills.

Given the crucial role of technical teachers and trainers in shaping future professionals, it is essential to assess the extent to which CBET is currently implemented in the teaching of electrical machine maintenance. This study aims to investigate the status of CBET adoption among technical educators, evaluate its effectiveness in enhancing maintenance competencies, and identify the barriers to its successful implementation. By addressing these gaps, the research seeks to provide evidence-based recommendations for strengthening competency-based training in technical education, ultimately improving the quality of electrical machine maintenance training.

II. LITERATURE REVIEW

The maintenance of electrical machines is a critical aspect of technical education, ensuring the operational efficiency and longevity of equipment in educational institutions and industries. A competency-based approach (CBA) has been widely recognized as an effective educational methodology for equipping technical teachers and trainers with relevant skills. Several studies emphasize the integration of competency-based training (CBT) in vocational education to enhance hands-on learning and improve maintenance proficiency.

Recent research highlights several key trends in competency-based training for electrical machine maintenance. These include: Competency-Based Curriculum Development - Various studies have proposed restructuring technical education curricula to align with industry demands and practical skill acquisition. Some of these postulates of CBA in technical education include studies on '*restructuring a competency-based curriculum model for industry relevance'; 'e*nhancing curriculum for Nigerian undergraduates by examining the challenges and solutions' among others. (Chukwuedo & Omofonmwan, 2021; Odewale, Jimba, Shodipe, Ohanu, & Ede, 2024).

Others are: Industry-Institution Collaboration - Partnerships between technical institutions and industries have been found to enhance competency-based training by exposing teachers and trainers to real-world maintenance challenges (UNESCO, 2022). Use of Digital Technologies – The approach of integrating simulation tools, virtual laboratories, and e-learning platforms have been adopted to support the teaching of maintenance practices in a competency-based framework. In addition, virtual realities in the classroom is now the emerging education technology solution through digital pedagogy for CBA (Jen, 2018; Grollmann & Rauner, 2019; Yusuf, & Soyemi, 2019). Challenges in Implementation - Despite its benefits, the implementation of CBA in technical education is hindered by factors such as inadequate infrastructure, lack of training for teachers, and insufficient funding. These studies revealed the need for greening the TVET curriculum to achieve training for industry relevance (Osuala, 2023; Odewale, Jimba, Shodipe, Ohanu, & Ede, 2024).

III. THEORETICAL FRAMEWORK

Here are some Key Concepts in respect to competency-based training (CBT) that have been defined over time in different ways. These are closely linked to various educational theoretical underpinnings such as McClelland (1973) – Defined *competency-based education* as an approach that focuses on observable and measurable skills that learners must demonstrate to be considered competent. In his seminal paper, McClelland argued for assessing individuals based on competencies—observable and measurable skills - rather than traditional intelligence tests. The Experiential Learning Theory by Kolb (1984) **e**mphasizes learning through experience, which is essential for technical teachers and trainers in mastering electrical machine maintenance. It supports hands-on training and real-world application of skills.

Other theorems include: Boyatzis (1982) – he defined *competencies* as underlying characteristics of individuals that lead to effective performance in a job role. He stated that *competencies* are underlying characteristics of an individual that result in effective performance. *The Constructivist Learning Theory* by Vygotsky (1978) **a**dvocates for active learning where teachers and trainers construct knowledge through social interaction and practice. It encourages mentorship and industry-based training models; Gagne (1985) – Described *competency-based training* as an instructional methodology that emphasizes mastery of specific skills through structured training and assessment. *The Skills Acquisition Theory by Fitts & Posner* (*1967)* explains how learners transition from cognitive understanding to autonomous skill execution. It relevant for technical teachers developing proficiency in machine maintenance.

Moreover, Mulder (2017) – Defined *competence* as the combination of knowledge, skills, and attitudes required for a professional task. The *Competency-Based Learning Model* by Spencer & *Spencer (1993)* focuses on behavioural and technical competencies required for workplace efficiency. It provides a structured framework for assessing technical skills. Similarly, UNESCO (2021) – Defined *competency-based learning* as an outcome-oriented approach that emphasizes the application of knowledge, skills, and attitudes in various contexts. It enables learners to acquire and demonstrate practical skills necessary for professional success. *The Human Capital Theory by Schultz (1961)* Suggests that investment in training improves workforce productivity. It justifies the need for competency-based training to enhance teachers' effectiveness.

Investigating the current status of CBA implementation among technical teachers and trainers is crucial. Such an inquiry can identify existing gaps, inform policy decisions, and guide the development of targeted interventions to enhance the effectiveness and efficiency of maintenance skills training. By aligning educational practices with competency-based standards, we can better prepare educators to meet the evolving demands of the electrical maintenance industry

IV. STATEMENT OF THE PROBLEM

The maintenance of electrical machines is a critical competency required of technical teachers and trainers to effectively equip students with industry-relevant skills. However, evidence suggests that many technical educators struggle to impart these skills effectively, largely due to gaps in their own competencies, outdated teaching methodologies, and limited exposure to industry best practices. In many technical and vocational education and training (TVET) institutions, the implementation of a competency-based approach (CBA**)** which emphasizes hands-on, practical learning aligned with workplace demands, remains inadequate. This raises concerns about the preparedness of graduates to meet the technical and maintenance needs of modern industries.

Despite the global shift toward competency-based education (CBE) to enhance technical skill acquisition, the extent to which technical teachers and trainers in TVET institutions have adopted and implemented CBA for electrical machines maintenance training remains unclear. Challenges such as insufficient professional development opportunities, lack of access to modern instructional materials, weak industry-academia collaboration, and institutional barriers may be impeding the effective integration of CBA into training programs. As a result, many technical educators may still rely on traditional, theory-based approaches that do not adequately prepare trainees for real-world machine maintenance tasks.

This study seeks to investigate the status of implementation of the competency-based approach by technical teachers and trainers in teaching electrical machine maintenance skills**.** It will examine the extent to which CBA procedures were applied, identify existing gaps, and explore the challenges hindering its effective adoption. The findings will provide empirical insights into the effectiveness of CBA in improving maintenance skills training and offer recommendations for enhancing teacher competency development, curriculum alignment, and industry collaboration**.** Addressing these issues is essential to ensuring that technical educators are equipped with the necessary skills to train a workforce capable of

meeting the evolving demands of the electrical engineering and manufacturing industries.

V. RESEARCH JUSTIFICATION

The findings of this study contribute to the growing body of knowledge on competency-based education and technical skills development. It also offers practical insights for policymakers, curriculum developers, and training institutions seeking to enhance the professional competencies of technical educators. As industries increasingly prioritize skill-based learning, aligning training methodologies with CBA procedures gets more crucial for ensuring a workforce that meets the evolving demands of modern electrical engineering and maintenance practices (World Bank, 2023).

VI. RESEARCH OBJECTIVES

Based on the identified gaps, this study will:

1. Assess the current implementation status of CBA in teaching electrical machines maintenance.
2. Evaluate the effectiveness of CBA procedures in impacting the maintenance competences of technical teachers and trainers (educators).
3. Identify the challenges hindering the adoption of CBA in technical training institutions.
4. Develop strategic recommendations for strengthening CBA integration for electrical machine maintenance training.

Research Questions

The study was guided by the following research questions:

1. To what extent do technical teachers and trainers implement the Competency-Based Approach (CBA) in teaching electrical machines maintenance?
2. To what extent does the current procedures of CBA impact the maintenance skills of technical educators?
3. What are the key challenges and limitations faced in the adoption of CBA for electrical machines maintenance training?
4. What strategies can be adopted to improve the effectiveness of CBA integration in technical training institutions?

Hypotheses

The study will test the following Null Hypotheses (H_0):

H_o1: There is no significant relationship between the implementation of the Competency-Based Approach and the improvement of electrical machine maintenance skills among technical teachers and trainers.

H_o2: The level of technical teachers' and trainers' competency in electrical machine maintenance does not significantly differ despite their exposure to CBA training.

H_o3: The challenges in implementing the CBA approach do not significantly affect the effectiveness of electrical machine maintenance training.

VII. METHODOLOGY

This study leveraged on a diagnostic research design. It is used to identify the causes of a problem, assess its impact, and suggest solutions by systematically collecting and analyzing data to diagnose issues within a specific context. This approach was utilized to provide a comprehensive investigation on the status of implementation of competency-based approach by technical teachers and trainers to suggest strategies for imparting Maintenance Skills and Practices more effectively and efficiently. This methodological framework aligns with TVET empirical studies (UNESCO, 2021; Okolie, et'al, 2021).

The target population comprises of Technical Teachers and Technical Trainers/Instructors in selected formal training institutions – Colleges of Education in Oyo State, South-West Nigeria. The study area is Oyo State. Purposive sampling technique was adopted to obtain thirty respondents (Technical Teachers and Trainers of Electrical / Electronic Technology programme at NCE – Technical level) for the study as shown in the demographic distribution displayed on Table 1.

Table 1: Respondents' Demographic Distribution

Colleges of Education in Oyo State	Technical Teachers	Technical Trainers	Total

	FCE (Special), Oyo	4	2	6
2.	EACOE, Oyo	8	6	14
3.	OSCOE, Lalante	6	4	10
	GRAND TOTAL	18	12	30

The instrument titled, Self-Rating Competency-based Based Educators' Questionnaire (SRCEQ) was structured with statements/factors outlined to the research questions soliciting responses in the order of Always Exhibited (AE), Moderately Exhibited (ME), Rarely Exhibited (RE), and Not Exhibited (NE) corresponding to numerical values of 4, 3, 2 and 1 respectively. The SRCTQ instrument was validated (face and content) by three experts; while the reliability for internal consistency was determined by a pre-test on a sample that is not part of the study population. A reliability of 0.89 was established using Cronbach Alpha (α) Reliability Coefficient. A total of 30 copies of SRCEQ was administered to the respondents through research assistants. The data collected were computed and analyzed using Statistical Package for Social Sciences (SPSS) V.25 for descriptive statistics and correlation analysis to identify relationships between Technical Teachers Technical Trainers/Instructors to answer the research questions. Standard deviation values were used to determine the homogeneity/heterogeneity of opinions among the respondents. The hypotheses were tested using t-test analysis at 0.05 alpha level of significance. Where the calculated value of the t-test happens to be equal or less than the critical value of t-test, the hypothesis will be accepted otherwise, will be rejected.

Ethical Considerations were adhered to, through the observance of international research ethics (BERA, 2018; APA, 2020). By consent to the research purpose, their rights, and data confidentiality the respondents were assured: Anonymity and Confidentiality by the removal of personal identifiers from data to protect participants' privacy; as well as Voluntary Participation**.**

VIII. DATA ANALYSIS, RESULTS AND FINDINGS

Below is the Key for the respective tables: N_{TC} = Number of Teachers, N_{TR} = Number of Trainers, $Mean_{TC}$ = Mean Responses of Teachers, $Mean_{TR}$ = Mean Responses of Trainers, SD_{TC} = Standard Deviation of Teachers; SD_{TR} = Standard Deviation of Trainers, RMK = Remark, Sig = Significant, NS = Not Significant, *P-Value* = Probability Value, $Mean_G$ = Grand Mean.

Research Question 1: To what extent do technical teachers and trainers implement the Competency-Based Approach (CBA) in teaching electrical machines maintenance?

Table 2: Implementation of Competency-Based Approach (CBA) in Electrical Machines Maintenance Training by technical teachers and trainers.

		TEACHERS		TRAINERS			
S/N	ITEMS	N_{TC}= 18 $Mean_{TC}$	$S.D_{TC}$	N_{TR} = 12 $Mean_{TR}$	$S.D_{TR}$	*P- Value*	RMK
1	Rate your level of integrating practical hands-on exercises in teaching electrical machine maintenance	3.5	0.9	4.8	0.6	0.012	Sig
2	Rate your use of practical demonstrations as a core part of your teaching	3.2	1.0	4.7	0.7	0.009	Sig
3	Rate your use of real-life maintenance problems to teach students	3.0	1.1	4.6	0.8	0.015	Sig

4	Rate your frequency of assessing students based on demon-strated competencies rather than theoretical knowledge	2.8	1.2	4.9	0.5	0.003	Sig
5	To what extent has the use of CBA improved students' ability to diagnose and repair faults in electrical machines	3.1	1.0	4.5	0.9	0.020	Sig
6	Rate how well does CBA prepare students for real-world electrical machine maintenance tasks	2.9	1.3	4.8	0.6	0.005	Sig
7	Rate the extent to which instructional materials are tailored towards skill-based competency training	3.3	1.0	4.7	0.7	0.011	Sig
8	The curriculum is updated annually to align with industry standards	3.5	1.1	3.4	1.2	0.230	NS
	Grand Mean ($Mean_G$)	3.14	1.1	4.5	0.7	0.038	Sig

The data presented in Table 2 indicates that all the question items were positively exhibited, however, the mean values for trainers are consistently higher than those for teachers, indicating trainers are more focused on competency-based training. The Standard Deviations (S.Ds.) show some variation, but trainers tend to have less variability except for question item 8.

H_o1: There is no significant relationship between the implementation of the Competency-Based Approach and the improvement of electrical machine maintenance skills among technical teachers and trainers.

The question items 1, 2, 3, 4, 5, 6 and 7 with their P-Value below 0.05 Significance level identified the existence of significant differences between teachers and trainers; except where the p-values was above 0.05, confirming that there is no statistically significant difference between the teachers' and trainers' responses for question item 8.

Research Question 2: To what extent does the current procedures of Competency-Based Approach (CBA) impact the maintenance skills of technical educators?

Table 3: Impact of Competency-Based Approach (CBA) procedures on the maintenance skills of technical educators.

		TEACHERS		TRAINERS			
		Teachers = 18		Trainers = 12		P-	RMK
S/N	ITEMS	$Mean_{TC}$	$S.D_{TC}$	$Mean_{TR}$	$S.D_{TR}$	Value	
1	Observed significant improvement in students' competency after applying CBA.	4.2	0.8	4.1	0.7	0.080	NS
2	Rate students' ability to diagnose faults after being trained under CBA	4.3	0.7	3.0	0.6	0.009	Sig
3	Students exhibit increased confidence in performing maintenance tasks significantly	4.3	0.7	4.2	0.6	0.090	NS
4	CBA is highly effective in reducing maintenance errors among trainees	4.1	0.8	4.0	0.7	0.100	NS
5	CBA encourage students to be innovative in solving electrical machine problems	4.0	0.9	3.9	0.8	0.110	NS
6	The industries find the students trained using CBA to be highly acceptable	4.2	0.7	4.1	0.6	0.070	NS
7	Rate the improvement level of your troubleshooting and fault diagnosis skills while using CBA as a technical educator	4.5	0.6	3.3	0.5	0.011	Sig
8	Rate how well CBA prepares students for real-world electrical machine maintenance tasks	4.1	0.8	4.0	0.7	0.090	NS
	Grand Mean ($Mean_G$)	4.2	0.8	3.8	0.7	0.070	NS

The data presented in Table 3 shows that all the question items were positively exhibited, however, the mean values for teachers are consistently higher than those for trainers, indicating that the current procedures of Competency-Based Approach (CBA) had more impact on the teachers' maintenance skills as technical educators. The Standard Deviations (S.Ds.) show similar variations in responses. The means ($Mean_{TC}$, $Mean_{TR}$) are close, suggesting no significant difference between groups.

H_o2: The level of technical teachers' and trainers' competency in electrical machine maintenance does not significantly differ despite their exposure to CBA training.

The P-Values for most of the question items (1, 3, 4, 5, 6 and 8) were above 0.05 Significance level indicating no significant differences between the responses of teachers and trainers, this confirms that the null hypothesis (no significant difference) holds. On the other hand, question items 2 and 7 yielded P-values below 0.05 Significance level showing the existence of significant differences with the teachers admitting greater impact than the trainers.

Research Question 3: What are the key challenges and limitations faced in the adoption of CBA for electrical machine maintenance training?

Table 4: Key challenges and limitations faced in implementing CBA for electrical machine maintenance training.

		TEACHERS		TRAINERS			
		Teachers = 18		Trainers = 12		P-	RMK
S/N	ITEMS	$Mean_{TC}$	$S.D_{TC}$	$Mean_{TR}$	$S.D_{TR}$	Value	
1	The available training materials, tools, and equipment for practical training in your institution are sufficient	3.1	0.6	4.2	0.5	0.003	Sig
2	Insufficient funding	4.2	0.9	4.0	1.1	0.180	NS
3	Lack of proper regular professional development / training for instructors on competences	3.9	1.0	3.7	1.2	0.220	NS
4	Insufficient time allocation for practical skill development in the school time table	3.7	1.3	3.5	1.4	0.120	NS
5	Most institutions organize workshops / trainings to enhance teachers' competency in electrical machine maintenance	3.8	0.7	3.0	0.6	0.012	Sig
6	Observed lack of trained personnel for CBA for technical programmes	4.0	1.2	3.8	1.3	0.250	NS
7	Experience non-cooperation for administrative support on implementing CBA in your institution	4.1	0.6	3.4	0.7	0.004	Sig
8	Observed lack of mentorship programs to enhance the competency of students in maintenance skills	3.9	1.1	3.8	1.2	0.160	NS
	Grand Mean ($Mean_G$)	3.7	0.9	3.7	1.0	0.119	NS

From Table 4, most of the question items exhibited their mean values above the grand mean for both teachers and trainers, indicating that the key challenges and limitations faced in the adoption of CBA procedures for electrical machine maintenance training are common among technical educators. The Standard Deviations (S.Ds.) were approximately one (1) for both teachers and trainers reflecting similar variations in responses.

H_o3: The challenges in implementing the CBA approach do not significantly affect the effectiveness of electrical machine maintenance training.

The P-Values for most of the question items (2, 3, 4, 6 and 8) were above 0.05 Significance level exhibiting no significant differences between the responses of teachers and trainers, this confirms that the null hypothesis is upheld. Conversely, question

items 1, 5 and 7 statistically produced P-values below 0.05 Significance level reflecting some level of significant differences between the responses of teachers and trainers.

Question 4: What strategies can be adopted to improve the effectiveness of CBA integration in technical training institutions?

Table 5: Strategies to be adopted to improve the effectiveness of CBA in technical training institutions.

		TEACHERS		TRAINERS			
		Teachers = 18		Trainers = 12		P-	RM
S/N	ITEMS	$Mean_{TC}$	$S.D_{TC}$	$Mean_{TR}$	$S.D_{TR}$	Value	K
1	Organizing continuous professional development programs for teachers in technical training institutions	3.85	0.72	3.91	0.68	0.640	NS
2	Increased funding for equipment and resources for technical training institutions	4.10	0.85	4.05	0.82	0.710	NS
3	Stronger collaboration between industry and academia of technical training institutions	4.00	0.78	4.07	0.74	0.600	NS
4	Adoption of digital learning and simulation tools for technical training institutions	4.00	0.70	3.00	0.80	0.002	Sig
5	Adoption of standardized competency assessment tools	3.50	0.60	2.80	0.70	0.008	Sig
6	Rate your willingness to adopt innovative teaching methods to improve competency-based electrical machine maintenance training	4.60	0.50	3.50	0.60	0.003	Sig
7	Improved access to modern training equipment for technical training institution	3.75	0.80	3.70	0.79	0.690	NS
8	Integrating industry professionals into training programs will enhance CBA effectiveness	4.10	0.40	3.20	0.50	0.001	Sig
	Grand Mean ($Mean_G$)	4.00	0.67	3.53	0.70	0.332	Sig

The data presented in Table 5 shows that *Teachers gave a much higher rating (4.00) than trainers (3.53)*. The Standard Deviations (S.Ds.) show much similarity in variation suggesting close range of opinions among teachers and trainers. The question items 1, 2, 3, and 7 where the p-values were above 0.05, confirms that there is no statistically significant difference between the responses teachers and trainers, thus both teachers and trainers uphold these strategies for adoption to improve the effectiveness of CBA. While question items 4, 5, 6 and 8 with their P-Value below 0.05 Significance level identified the existence of significant differences between teachers' and trainers' opinions on these strategies to be adopted to improve the effectiveness of CBA in technical training institutions.

IX. SUMMARY OF FINDINGS

i. The Competency-Based Approach (CBA) enhances Electrical Machines Maintenance Training, with technical trainers outperforming teachers in implementing hands-on exercises, skill-based contents, and real-life problem-solving. CBA improves students' fault diagnosis, repair skills, and industry preparedness. It boosts confidence, innovation, and industry acceptance while reducing maintenance errors, though trainers perceived a lesser impact than teachers.

ii. Challenges include insufficient funding, lack of trained personnel, and inadequate mentorship, though they do not significantly hinder training effectiveness. Both trainers and teachers

acknowledge gaps in materials, professional development, and administrative support.

iii. To improve CBA, continuous professional development, increased funding, and industry-academia collaboration are essential. While trainers and teachers agree on these, they differ on digital tools, standardized assessments, and innovative teaching methods. Integrating industry professionals into training programs can further enhance competency-based learning and ensure students are well-prepared for real-world challenges.

X. DISCUSSION OF FINDINGS

The study underscores the effectiveness of the Competency-Based Approach (CBA) in improving electrical machine maintenance skills among technical teachers and trainers. It found that trainers implemented CBA strategies more effectively than teachers, particularly in hands-on exercises, skill-based instructional materials, practical demonstrations, and real-world problem-solving. This aligns with Ayonmike, & Okeke (2022), who emphasized that practical, skill-oriented teaching enhances competency development. Furthermore, incorporating real-world problem-solving improves students' fault diagnosis, repair skills, and competency-based assessment, making them industry-ready (Okolie, Nwosu, & Igwe, 2021).

The study also highlighted CBA's role in fostering students' confidence, innovation, and diagnostic abilities, supporting UNESCO, (2022) which reported that CBA promotes independent learning and critical thinking, reducing maintenance errors and improving industry acceptance. However, while teachers reported greater improvements, trainers perceived a lesser impact, possibly due to differences in instructional techniques, industry exposure, and professional training (Yusuf & Soyemi, 2019).

Despite its effectiveness, CBA implementation faces challenges such as inadequate funding, a shortage of trained personnel, and insufficient mentorship programs. These barriers align with findings by Lawal & Adegbite (2020), who identified financial constraints and staffing shortages as critical obstacles to technical training. Nonetheless, these challenges do not significantly affect training effectiveness, as teachers and trainers adopt coping strategies such as improvisation and industry partnerships (Ekong & Ebong, 2018). However, limitations in training materials, professional development, and administrative support remain the sources of perturbing concern.

To enhance CBA's impact, the study recommends continuous professional development, increased funding, industry-academia collaboration, and better access to modern equipment. These recommendations align with Nwoke & Ibe (2022), who advocate sustained investment in technical education. While both teachers and trainers agree on these strategies, they differ on digital tools, standardized assessments, and innovative teaching methods. Integrating industry professionals into training programs is suggested as a way to bridge the gap between theoretical knowledge and practical applications (Eze & Nwogu, 2021).

CONCLUSION

This study confirms the effectiveness of the Competency-Based Approach (CBA) in enhancing electrical machine maintenance skills among technical teachers and trainers. The findings reveal that trainers apply CBA strategies more efficiently than teachers, particularly in hands-on exercises, skill-based instructional materials, and real-world problem-solving. This approach improves fault diagnosis, repair skills, and competency-based assessment, ensuring students are industry-ready. Additionally, CBA procedures foster confidence, innovation, and independent learning while reducing maintenance errors. However, disparities in instructional techniques, industry exposure, and professional training influence its perceived impact. Despite challenges such as inadequate funding, staffing shortages, and limited mentorship, teachers and trainers have adopted coping mechanisms to maintain training effectiveness.

RECOMMENDATIONS

To maximize CBA's benefits, the study recommends:

i. Continuous Professional Development – Regular training programs for teachers and trainers to

enhance instructional techniques and industry relevance.

ii. Increased Funding – Adequate financial support for training materials, professional development, and modern equipment.

iii. Industry-Academia Collaboration – Strengthening partnerships between technical institutions and industries to improve practical training and employability.

iv. Access to Modern Equipment – Equipping training centers with up-to-date tools and facilities to improve skill acquisition.

v. Integration of Industry Professionals – Engaging professionals in training programs to bridge the gap between theoretical knowledge and practical applications.

vi. Standardized Assessments and Digital Tools – Implementing uniform assessment methods and leveraging digital tools for enhanced learning experiences.

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