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CREATIVITY SKILLS NEEDED BY ELECTRICAL INSTALLATION STUDENTS FOR DOMESTIC AND INDUSTRIAL INSTALLATION IN TECHNICAL COLLEGES OF GOMBE STATE

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ABSTRACT

This study investigated the creativity skills needed by Electrical Installation and Maintenance Works (EIMW) students for domestic and industrial installation tasks in technical colleges of Gombe State, Nigeria. Anchored on Piaget's (1950) cognitive constructivism, complemented by Dewey's (1938) and Kolb's (1984) experiential learning perspectives, the study adopted a descriptive survey design and drew its population from all 21 administrators and 54 EIMW teachers across the seven Government Science and Technical Colleges (GSTCs) in Gombe State, giving a census sample of 75 respondents. Data were collected using a validated 20-item structured questionnaire (Cronbach's alpha = 0.87) and analysed using mean, standard deviation, and independent-samples t-test at the 0.05 level of significance. Findings revealed nine creativity skills needed for domestic installation, including designing customised electrical layouts, applying innovative wiring techniques, and interpreting and modifying blueprints (cumulative mean of 3.79 across all ten domestic items, including the one item that fell below the 3.50 cut-off). For industrial installation, eight creativity skills were identified, including designing industrial control panels, integrating renewable energy into industrial setups, and implementing automation in electrical systems (cumulative mean of 3.65 across all ten industrial items, including the two items that fell below the cut-off). The t-test results showed no statistically significant difference between the perceptions of administrators and teachers for either domestic installation ($t = 0.84$, $p = 0.40$) or industrial installation ($t = 1.56$, $p = 0.12$), indicating a shared understanding of these creativity needs across both groups of stakeholders. The study recommends that technical colleges in Gombe State prioritise the procurement of modern tools, structured hands-on exercises, and blueprint-interpretation practice to nurture these creativity skills among EIMW students.

Keywords: Creativity Skills, Domestic Electrical Installation, Industrial Electrical Installation, Technical Colleges, Electrical Installation and Maintenance Works, Practical Skills

Introduction

Technical education equips learners with practical skills, knowledge, and competencies tailored to specific vocations such as engineering, agriculture, and information technology (UNESCO, 2015). Within Nigeria's technical college system, Electrical Installation and Maintenance Works (EIMW) is a core trade whose graduates are expected to design, install, and maintain electrical systems across residential and industrial settings (Federal Republic of Nigeria [FRN], 2013). While technical proficiency has traditionally dominated discourse on EIMW training, creativity is increasingly recognised as an equally indispensable competency, enabling graduates to move beyond rote application of standard procedures toward innovative, context-responsive problem-solving (Amabile, 1996; National Board for Technical Education [NBTE], 2020).

Domestic and industrial electrical installation represent two of the most fundamental content areas within the EIMW curriculum. Domestic installation concerns the design, wiring, and maintenance of residential electrical systems, while industrial installation involves the more complex, higher-voltage systems that power factories and manufacturing plants (Olawale & Yusuf, 2020). Both domains increasingly demand creative competence: domestic electricians must customise wiring layouts, integrate smart-home technologies, and adapt systems to household energy demands (Adegbite & Nwosu, 2021), while industrial electricians are expected to design control panels, integrate automation, and develop cost-effective solutions for large-scale operations (Adebayo & Uchenna, 2020).

Despite this recognition, technical education in Nigeria is widely reported to be constrained by outdated equipment, insufficient workshop facilities, and weak industry-academia collaboration, which limit the extent to which practical training can cultivate creativity among students (Uwaifo, 2011 World Bank, 2019). Gombe State has seven Government Science and Technical Colleges (GSTCs), of which six offer the EIMW trade. Existing evidence indicates that EIMW graduates in the state generally lack the technical skills required for self-employment, and are unable to operate electrical maintenance workshops independently. In terms of training conditions, electrical installation equipment in Gombe State is rated as "moderately available," with some key equipment such as conduit benders and battery chargers not reaching high availability levels. At the same time, TVET enrolment in Gombe State is seriously imbalanced, with only 2,046 TVET students in the 2020/2021 academic year, compared to over 47,000 in science secondary schools. A study on GSTCs found that there was no significant difference in the perceptions of administrators and EIMW teachers regarding teacher-related factors affecting practical skill acquisition ($p > 0.05$), suggesting that the two groups may have a consistent cognitive basis for identifying creativity skills needs (Yidi, & Adeniyi, 2026; Adamu, Babayo, Jibril, Amtai, & Mukhtar, 2024). It was against this backdrop that this study set out to determine the specific creativity skills needed by EIMW students for domestic and industrial installation tasks, and to establish whether administrators and teachers hold similar perceptions of these needs.

Statement of the problem

Creativity is central to effective electrical installation practice, yet the literature suggests that practical skill development in Nigerian technical colleges often receives limited emphasis, potentially constraining students' creative problem-solving capacity in both domestic and industrial installation tasks (Ayuba, 2016). Where hands-on exposure is inadequate, students risk becoming narrow, rule-bound technicians rather than adaptable professionals capable of customising solutions to varied residential and industrial contexts (Ogunleye, 2021). Published

evidence specific to Gombe State on which creativity skills EIMW students need is limited, which makes it difficult for colleges to target creativity-oriented training. This gap threatens graduate employability and Gombe State's broader industrialisation goals, underscoring the need to identify, empirically, which creativity skills require deliberate cultivation.

Purpose of the study

The study was designed to determine the creativity skills needed by EIMW students in technical colleges of Gombe State for:

1. Domestic installation practical task performance.
2. Industrial installation practical task performance.

Research questions

i. What are the creativity skills needed to enhance electrical installation students' performance in domestic installation in technical colleges of Gombe State?

ii. What are the creativity skills needed to enhance electrical installation students' performance in industrial installation in technical colleges of Gombe State?

Hypotheses

H_{01}: There is no significant difference between the mean responses of administrators and teachers on the creativity skills needed to enhance electrical installation students' performance in domestic installation in technical colleges of Gombe State at the 0.05 level of significance.

H_{02}: There is no significant difference between the mean responses of administrators and teachers on the creativity skills needed to enhance electrical installation students' performance in industrial installation in technical colleges of Gombe State at the 0.05 level of significance.

Literature review

Theoretical framework

The study was anchored on Piaget's (1950) cognitive constructivism, which holds that learners actively construct knowledge through direct experience and interaction with their environment, restructuring their existing understanding (through assimilation and accommodation) when it fails to explain what they encounter. Applied to EIMW training, the theory suggests that students build the knowledge that underlies creative practice by working with real circuits, materials, and faults rather than through passive reception of theoretical content.

Piaget's theory is, however, a general theory of cognitive development and does not by itself explain how trade-specific creative skill is acquired. The study therefore complements it with two perspectives that address learning through practice. Dewey's (1938) philosophy of experience holds that learning arises from purposeful, problem-oriented activity in which learners reflect on the consequences of their actions. Kolb's (1984) experiential learning theory describes learning as a cycle of concrete experience, reflective observation, abstract conceptualisation, and active experimentation. In an EIMW workshop, this cycle is visible when a student wires a circuit (concrete experience), observes why a fault occurs (reflection), formulates a modified layout or technique (conceptualisation), and tests it (experimentation). Together, the three perspectives justify treating creativity in installation work as a capacity developed through active, reflective practice, and therefore as something colleges can deliberately cultivate through the tasks, tools, and projects they provide.

Within this framework, the creativity skills examined in this study (for example, designing layouts, modifying circuits, interpreting and adapting blueprints, and designing control panels) are those that require the learner to generate, test, and refine solutions. The findings are interpreted in this light in Section 5.0.

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Concept of creativity

Creativity is commonly defined as the capacity to produce work that is both novel (original and unexpected) and appropriate (useful and fitting the constraints of the task) (Runco & Jaeger, 2012; Sternberg & Lubart, 1999). Early work by Guilford (1950) framed creativity as a set of abilities, such as fluency, flexibility, and originality of thought, that can be identified and developed, while Amabile's (1996) componential model locates creativity in the interaction of domain-relevant skills, creativity-relevant processes, and task motivation.

For the purposes of this study, creativity in electrical installation is defined as the ability of an installer to generate and apply original yet safe, workable, and cost-appropriate solutions to design, installation, modification, and fault-finding problems, going beyond routine application of standard procedures. This definition has two implications. First, it distinguishes creative competencies from routine technical or compliance tasks. Second, it recognises that technical (domain-relevant) skill is a necessary but insufficient condition for creative performance (Amabile, 1996).

Creativity in domestic electrical installation

Domestic electrical installation covers wiring, lighting, power distribution, circuit protection, and appliance integration within residential buildings (Olawale & Yusuf, 2020). Creativity in this domain enables electricians to optimise wiring layouts, integrate energy-efficient solutions, and troubleshoot faults more effectively (Okonkwo & Yusuf, 2020). The growing adoption of smart-home automation, energy-efficient lighting, and solar integration has expanded the creative demands placed on domestic installers, requiring them to combine traditional wiring competence with adaptive, technology-responsive thinking (Adegbite, 2021; Adeyemi & Uchenna, 2021).

Creativity in industrial electrical installation

Industrial electrical installation involves higher-voltage, more complex systems supporting factories, manufacturing plants, and other large-scale facilities, including three-phase power distribution, automation systems, and programmable logic controllers (Adamu & Eze, 2021; Nwosu & Adegbite, 2022). Creativity and innovation are considered critical in this domain because modern industries require efficient, adaptable, and sustainable electrical solutions; innovative approaches such as renewable energy integration, smart grid systems, and predictive maintenance can enhance operational efficiency and reduce costs (Adebayo & Uchenna, 2020). Technology-assisted approaches, such as augmented reality, are also being applied to industrial maintenance work (Ibrahim & Okeke, 2021).

Empirical studies

Studies that treat creativity itself as an outcome of technical training are few. In engineering education, Charyton and Merrill (2009) examined how general creativity and creative engineering design performance can be assessed among first-year engineering students, treating creativity as a distinct and measurable outcome of technical training, and Daly, Mosyjowski, and Seifert (2014) reviewed and synthesised the instructional approaches used to foster creativity in engineering courses. In the electrical installation context, Okonkwo and Yusuf (2020) addressed creativity and problem-solving skills in installation training, and Adegbite and Nwosu (2021) discussed the roles of innovation and adaptability in enhancing creativity in electrical installation.

Other studies have examined related constructs. Udofia and Udo (2020) investigated the constraints on students' acquisition of EIMW skills in technical colleges in Akwa Ibom State, and Ibrahim and Danlami (2021) examined the influence of hands-on learning strategies on

students' competency in EIMW in Kaduna State. Nwosu and Adeyemi (2022), using a randomised controlled trial, found that students trained with digital simulations performed 25% better on troubleshooting tasks than those taught conventionally, underscoring the value of practical, technology-mediated training. Ahmed and Bala (2021) similarly examined the role of hands-on training in enhancing EIMW students' competency, while Yusuf and Danjuma (2020) examined the role of modern training facilities in enhancing electrical installation skills. While these studies affirm the value of practical training in general competency development, none explicitly isolated creativity as a distinct, measurable outcome across domestic and industrial installation tasks in Gombe State, a gap the present study addresses.

Methodology

The study adopted a descriptive survey research design. The population comprised all 75 stakeholders across the seven Government Science and Technical Colleges (GSTCs) in Gombe State, made up of 21 administrators (principals and vice-principals) and 54 EIMW teachers. Because the population was of manageable size, census sampling was employed, and all 75 respondents were retained as the study sample.

Data were collected using a section of the researcher-developed "Enhancing the Creativity of Electrical Installation Students Questionnaire" (ECEISQ), comprising 20 items across two thematic parts: domestic installation (items 1-10) and industrial installation (items 11-20). Responses were rated on a five-point scale: Very Highly Needed (5), Highly Needed (4), Moderately Needed (3), Slightly Needed (2), and Not Needed (1). The instrument was validated by three experts from the Department of Electrical Technology Education, Modibbo Adama University, Yola, and trial-tested on eight respondents in GSTC Yola, yielding a Cronbach's alpha reliability coefficient of 0.87. Seventy-five copies of the questionnaire were administered and all 75 were returned, giving a 100% return rate and Data were analysed using SPSS version 26.0. Research questions were answered using mean and standard deviation. A cut-off mean of 3.50 was adopted from the real limits of the scale categories (4.50-5.00 = Very Highly Needed; 3.50-4.49 = Highly Needed; 2.50-3.49 = Moderately Needed; 1.50-2.49 = Slightly Needed; 1.00-1.49 = Not Needed). A mean of 3.50 is the lower limit of the "Highly Needed" category, so items scoring 3.50 and above were regarded as "Needed", while items below 3.50 were not endorsed as needed creativity skills and are labelled "Not Needed" in the tables. The scale mid-point (3.00) was not used because it would have classified items rated only "Moderately Needed" as needed creativity skills. Hypotheses were tested using the independent-samples t-test at the 0.05 level of significance.

Items were retained as indicators of creativity where the task, as practised in the installation trades, requires the installer to make design or adaptation decisions rather than follow a fixed procedure. For example, item 2 (installing energy-efficient lighting systems) requires choosing and arranging luminaires, controls, and circuits to meet a lighting and energy target in a particular building; item 16 (constructing and testing industrial transformers) involves specifying, assembling, and troubleshooting a device to meet given performance requirements; and item 20 (maintaining and upgrading electrical machinery) frequently calls for improvised, retrofit solutions where original parts or specifications are unavailable. These three items lie closer to technical competence than the other items, and their ratings are therefore interpreted as perceived needs for the creative application of technical skill (see Section 5.0).

For the hypothesis tests, each respondent's overall mean rating was first computed across the ten domestic items (Ho1) and, separately, across the ten industrial items (Ho2), giving one score per respondent for each part. These respondent-level scores were then compared between

administrators (n = 21) and teachers (n = 54) using the independent-samples t-test with df = n_1 + n_2 − 2 = 73. The group means in Tables 3 and 4 are therefore the averages of these respondent-level scores and correspond to the cumulative means in Tables 1 and 2. The t-test assumes equal variances in the two groups. Levene's test was conducted for each hypothesis, yielding F and p for H_{01} and F and p for H_{02}. Because the group sizes are unequal and the group standard deviations differ (Tables 3 and 4), a robustness check using Welch's unequal-variances t-test was also computed from the summary statistics (Section 4.3).

Results

Research question 1: Creativity skills needed for domestic installation

Table 1 presents the mean and standard deviation of responses on the creativity skills needed for domestic installation.

Table 1: Mean and Standard Deviation of Respondents on Creativity Skills Needed for Domestic Installation (NA = 21, NT = 54, N = 75)

S/N	Item	Mean (Admin)	Mean (Teachers)	Grand Mean	SD	Remark
1	Ability to design customised electrical layouts for homes	4.38	4.33	4.34	1.13	Needed
2	Ability to install energy-efficient lighting systems	3.67	3.50	3.55	0.70	Needed
3	Skill in troubleshooting household electrical faults creatively	4.52	3.85	4.04	1.33	Needed
4	Competence in using innovative wiring techniques	3.76	4.39	4.21	0.70	Needed
5	Ability to modify electrical circuits for varying power loads	4.48	3.83	4.01	1.46	Needed
6	Knowledge of smart home automation and integration	3.67	3.61	3.63	0.75	Needed
7	Skill in using modern electrical tools innovatively	2.76	2.37	2.48	0.68	Not Needed
8	Ability to interpret and modify electrical blueprints	4.57	4.39	4.44	0.95	Needed
9	Creativity in using alternative energy sources in homes	3.67	3.61	3.63	0.63	Needed
10	Skill in developing safety measures for home installations	3.52	3.56	3.55	1.47	Needed
	Cumulative Mean (all 10 items)	**3.90**	**3.74**	**3.79**	**0.98**	**Needed**

Table 1 shows that respondents affirmed nine of the ten domestic installation items as needed creativity skills, with grand means ranging from 3.55 to 4.44. Only item 7 ("skill in using modern electrical tools innovatively") was rated below the 3.50 cut-off (mean = 2.48), suggesting respondents did not consider this a distinct creativity need, possibly because it overlaps with general technical competence rather than creative capacity. The cumulative mean

of 3.79 is the average across all ten items, including item 7, and indicates that creativity skills are highly needed for domestic installation overall; the nine items at or above the cut-off are the specific skills identified as needed to enhance EIMW students' performance in domestic installation.

Research question 2: Creativity skills needed for industrial installation

Table 2 presents the mean and standard deviation of responses on the creativity skills needed for industrial installation.

Table 2: Mean and Standard Deviation of Respondents on Creativity Skills Needed for Industrial Installation (NA = 21, NT = 54, N = 75)

S/N	Item	Mean (Admin)	Mean (Teachers)	Grand Mean	SD	Remark
11	Ability to design industrial electrical control panels	4.52	3.83	4.03	1.23	Needed
12	Skill in integrating renewable energy into industrial setups	3.67	3.61	3.63	1.01	Needed
13	Competence in innovative problem-solving in industrial faults	3.76	3.85	3.83	1.01	Needed
14	Ability to implement automation in electrical systems	4.48	3.20	3.56	1.76	Needed
15	Creativity in designing power distribution systems	2.76	3.30	3.15	0.78	Not Needed
16	Ability to construct and test industrial transformers	3.76	3.74	3.75	0.86	Needed
17	Competence in using advanced industrial electrical tools	4.57	4.06	4.20	1.27	Needed
18	Skill in developing cost-effective electrical solutions	3.76	3.44	3.53	0.84	Needed
19	Creativity in implementing workplace safety in electrical works	2.76	2.63	2.67	0.53	Not Needed
20	Ability to maintain and upgrade electrical machinery	4.52	4.09	4.21	1.23	Needed
	Cumulative Mean (all 10 items)	**3.86**	**3.58**	**3.65**	**1.05**	**Needed**

Table 2 shows that eight of the ten industrial installation items were affirmed as needed creativity skills, with grand means ranging from 3.53 to 4.21. Items 15 ("creativity in designing power distribution systems", mean = 3.15) and 19 ("creativity in implementing workplace safety in electrical works", mean = 2.67) fell below the cut-off. The cumulative mean of 3.65 is the average across all ten items, including items 15 and 19, and indicates that creativity skills are

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highly needed for industrial installation overall; the eight items at or above the cut-off are the specific skills identified as needed to enhance EIMW students' performance in industrial installation.

Hypotheses testing

Hypothesis 1 (Domestic Installation): Table 3 shows the t-test comparison of administrators' and teachers' mean responses.

Table 3: t-test Analysis of Difference between Mean Responses of Administrators and Teachers on Domestic Installation

Respondents	N	Mean	SD	df	t-value	p-value	Decision
Administrators	21	3.90	0.96				
Teachers	54	3.74	0.64	73	0.84	0.40	Not Rejected

With t = 0.84, df = 73, and p = 0.40 (p > 0.05), the null hypothesis was not rejected, indicating no statistically significant difference between the perceptions of administrators (mean = 3.90) and teachers (mean = 3.74) regarding the creativity skills needed for domestic installation. Because the administrators' standard deviation (0.96) was larger than the teachers' (0.64), Welch's unequal-variances t-test was also computed from the summary statistics and led to the same decision (t = 0.71, p = 0.49).

Hypothesis 2 (Industrial Installation): Table 4 shows the corresponding t-test comparison.

Table 4: t-test Analysis of Difference between Mean Responses of Administrators and Teachers on Industrial Installation

Respondents	N	Mean	SD	df	t-value	p-value	Decision
Administrators	21	3.86	0.97				
Teachers	54	3.58	0.56	73	1.56	0.12	Not Rejected

With t = 1.56, df = 73, and p = 0.12 (p > 0.05), the null hypothesis was not rejected, indicating no statistically significant difference between the perceptions of administrators (mean = 3.86) and teachers (mean = 3.58) regarding the creativity skills needed for industrial installation. As the administrators' standard deviation (0.97) was again larger than the teachers' (0.56), Welch's unequal-variances t-test was also computed and led to the same decision (t = 1.24, p = 0.22).

Discussion of findings

The findings on domestic installation identified nine creativity skills, including designing customised electrical layouts, applying innovative wiring techniques, modifying circuits for varying power loads, integrating smart-home automation, interpreting and modifying blueprints, using alternative energy sources, and developing safety measures. These findings are consistent with the emphasis that Adegbite and Nwosu (2021) and Okonkwo and Yusuf (2020) place on creativity, innovation, and adaptability in electrical installation, and with Adegbite (2021) and Adeyemi and Uchenna (2021), who point to smart-home, energy-efficient, and solar technologies as growing demands on domestic installers. The highest-rated domestic skills, interpreting and modifying blueprints (4.44) and designing customised layouts (4.34), are skills learned through practice, which fits studies showing that hands-on training and modern training facilities improve EIMW students' competency (Ahmed & Bala, 2021; Yusuf & Danjuma, 2020), although those studies concerned general competence rather than creativity. The concern of Udofia and Udo (2020) with constraints on EIMW skills acquisition in technical colleges also underlines why such skills require deliberate attention.

For industrial installation, the study identified eight creativity skills, including designing industrial control panels, integrating renewable energy, innovatively troubleshooting industrial

faults, implementing automation, constructing and testing transformers, using advanced industrial tools, developing cost-effective solutions, and maintaining and upgrading machinery. These findings agree with the view that innovation is central to industrial electrical engineering (Adebayo & Uchenna, 2020) and with the growing role of automation in industrial installations (Adamu & Eze, 2021). The high rating of maintaining and upgrading machinery (4.21) also accords with the increasing use of technology-assisted maintenance (Ibrahim & Okeke, 2021), and the importance of practice-based learning for these skills is in line with Ibrahim and Danlami (2021), who examined hands-on learning strategies and EIMW competency in Kaduna State.

Notably, respondents did not regard general tool-use proficiency (domestic item 7) or workplace-safety implementation (industrial item 19) as distinctly creative competencies, suggesting that stakeholders differentiate between routine technical/safety compliance and the generative, adaptive problem-solving that defines creativity. This distinction is instructive for curriculum designers: creativity-focused interventions should target design, customisation, and innovative troubleshooting rather than standard tool operation or compliance procedures alone. Items 2, 16, and 20, which sit closest to routine technical competence (Section 3.0), should be interpreted with caution, particularly item 2, whose mean (3.55) only marginally exceeded the cut-off.

The findings can also be interpreted through the study's theoretical framework. The skills rated highest, such as interpreting and modifying blueprints, designing layouts and control panels, and troubleshooting faults, are those in which learners must repeatedly act, observe the outcome, and adjust their solution, which is the cycle described by Kolb (1984) and the learning-by-doing principle of Dewey (1938). From Piaget's (1950) standpoint, these tasks require students to restructure existing knowledge when a circuit, load, or fault does not behave as expected. The low ratings for tool use (item 7) and safety implementation (item 19) are consistent with this reading, since both are largely rule-governed procedures that call for little restructuring of knowledge. Designing power distribution systems (item 15) was also rated below the cut-off, which may reflect the standards-governed nature of that task and merits further study. The framework therefore supports the recommendation that colleges provide workshop tasks that demand design decisions and reflection, not merely repetition of standard procedures.

The non-significant t-test results for both domestic ($p = 0.40$) and industrial installation ($p = 0.12$) indicate that administrators and teachers, despite occupying different institutional roles, share a broadly consistent understanding of the creativity skills EIMW students need. This convergence strengthens the credibility of the findings and suggests that any curriculum reform informed by this study may receive support from both groups of stakeholders.

Conclusion

The study concludes that fostering creativity in both domestic and industrial electrical installation is essential for producing EIMW graduates who can move beyond rote technical execution to innovative, context-responsive practice. Nine domestic and eight industrial creativity skills were identified as needed by administrators and teachers alike, with no significant difference in perception between the two groups. Equipping students with these skills would strengthen their employability, adaptability, and capacity to contribute meaningfully to Gombe State's residential and industrial electrification needs.

Recommendations

Based on the findings, the following recommendations are made:

1. Technical colleges in Gombe State should be equipped with modern tools and materials that allow students to practise customised residential layout design, blueprint interpretation, and smart-home integration.
2. Instructors should incorporate structured, project-based exercises in industrial control-panel design, automation, and transformer construction to build industrial installation creativity.
3. Curriculum planners should explicitly distinguish creativity-oriented learning outcomes from routine tool-use and compliance training, ensuring that instructional time is allocated to genuinely generative tasks.
4. The Gombe State Ministry of Education should facilitate partnerships between technical colleges and local industries to expose students to authentic, large-scale industrial installation challenges.
5. Regular in-service training should be organised for EIMW teachers to keep them abreast of emerging domestic and industrial installation technologies, including renewable-energy integration and automation systems.

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